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ETHNOLOGY.—*Utilization of marine life by the Wampanoag Indians of Massachusetts.*[1] FRANK G. SPECK, University of Pennsylvania, and RALPH W. DEXTER, Kent State University. (Communicated by WILLIAM N. FENTON.)

Coastal Indians have always possessed a unique advantage. Marine resources have been at their disposal for use in many ways, especially for food. Undoubtedly marine foods played the most important part in the diet of these aboriginals as indicated by numerous prehistoric shell heaps, and also by the persistence to the present day of the use of marine animals by the living descendants of the shell-heap builders. The writers have made a study of the use of marine life, with special reference to the marine invertebrates, by the Wampanoag Indians living at Mashpee on Cape Cod and at Gay Head on Marthas Vineyard. Information obtained from informants[2] portrays the use of marine life from about 1850 to the present. This is correlated with published records on the contents of shell heaps which have been excavated in the region.

A preliminary survey was made at Mashpee and Gay Head in August 1940. In 1946 a concentrated study was made in the Mashpee area (including Herring Pond). In 1947 a brief revisit to this area and a concentrated study with the Gay Head group was undertaken. Table 1 summarizes the marine life known to have been used by the Wampanoag, and compares marine forms cited by living Indians with marine life collected in the vicinity and with remains recovered from local shell heaps.

Byers and Johnson (1940) characterize the Wampanoag as "a rather undeveloped fishing and hunting people" and say that "shellfish were the principal part of their diet." Earlier, Chase (1885) stated that they were "largely dependent for food upon the fish and shellfish which they caught at the mouth of streams and sheltered bays." In reporting an early journey of Edward Winslow and Stephen Hopkins with Squanto from Plymouth to Narragansett Bay, Miller (1880) described the travelers meeting Indians "with baskets of roasted crab fishes and other dried shell fish." They also encountered Indians fishing for bass at a weir on the Taunton River, and "at Mattapoiset they ate oysters and other fish." Miller also pointed out that "as soon as the shores were clear of snow and ice, in the spring, they would naturally flock to them, for shellfish, and watch for the coming of the early sea fish." The abundant shell heaps of coastal Massachusetts leave no doubts as to the importance of marine life, especially the mollusks, in the economy of the aboriginals. There is also evidence that the Indians of the interior journeyed to the coast to obtain shellfish, which were smoked or dried for winter use.

The salt-water ponds, inlets, and bays along the shore have provided sea foods for these people for many centuries. Squibnocket Pond at Marthas Vineyard is no longer connected with the sea, but Guernsey (1916) presented evidence that the Indians

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had opened it to the sea with a channel way for the purpose of introducing marine fish and shellfish. Such ponds as Menemsha Pond and Tisbury Pond still furnish them with food. In August 1947, the junior writer accompanied Linus Jeffers of the Gay Head band on a trip into Menemsha Pond for the collection of shellfish, and notes were taken on the marine life available there for comparison with archeological records and recent ethnological information on the use of such marine organisms in past and recent times by the inhabitants of Gay Head. Fresh-water ponds such as Mashpee Pond, and Herring Pond have long provided an abundance of such fishes as the alewife or fresh-water herring. While the sea foods once formed the bulk of their diet, and marine animals were adapted for many uses in their culture, the Wampanoag have gradually become less and less dependent upon marine resources, although they are still important as items of food. The ethnic character of these people has been described by Speck (1928).

Of all the marine invertebrates utilized by the Wampanoag, the pelecypods or bivalve mollusks have been of the greatest importance. Many species were common items of food, some were used in tempering clay for pottery, and some were used for beads, scrapers, and ornaments. The oyster (*Ostrea virginica*) was at one time a staple food. This mollusk lived in Menemsha Pond, and other salt-water ponds at Gay Head, and probably in sheltered bays along the southern shore of Cape Cod. In recent times this species has become scarce in the locality of this study. Efforts have been made by present day Indians to reintroduce the oyster into the salt-water ponds at Gay Head without success, so that now it is obtained only through commercial sources. In former times, however, the oyster was undoubtedly fished in large quantities and eaten frequently, as attested by the great bulk of oyster shells found in many of the excavated shell heaps. In modern times they are stored by spreading them over a basement floor with the deep shell down and sprinkled with corn meal, or packed in seaweed in a cool, dark place.

Equally important as the oyster was the bay scallop (*Pecten irradians*). This shellfish was also obtained from the salt-water ponds and inlets, and today still ranks first among local food mollusks. As in the case of the oyster, shell heaps reveal a large consumption of this bivalve. Some shell heaps are largely oyster shells; others are largely scallop shells. At times the two are mixed, and at other times there are alternating layers of the two species. The latter case may indicate fluctuations of abundance of these mollusks from one time to another, or the greater availability of one over the other at certain seasons. Besides food, scallops were used in the manufacture of pottery. Byers and Johnson (1940) found that "By far the greatest number of sherds are tempered with scallop shell." An interesting superstition of recent times among the Gay Head Indian people is the belief that domestic cats, which eat the rim of the scallop (edge of the mantle containing the eyes), have their ears rot off in a short time.

The quahog (*Mercenaria mercenaria*) ranks third in importance in the all-time list, although in recent times it shares with the scallop the honor of first place. Quahog shells are abundant in the shell heaps, and today it is the commonest clam consumed in the area. They are obtained by treading in shallow water and by the use of quahog rakes in deeper water. They are stored by spreading out on cool basement floors. In addition to steaming and frying, they are used in clam chowder, clam fritters, and clam pie. They have also been used for bait although less valuable shellfish are now substituted for that purpose. In pre-historic and proto-historic times purple wampum or beads were cut from the purple nacre of the quahog shells. Chase (1885) found quahog shells perforated in such a manner as to suggest they had been strung in the form of a necklace.

The soft-shelled clam (*Mya arenaria*) is another common bivalve that has been in use over a long period of time, but this species is no longer as important on the south shore of Massachusetts as it is and has long been along the coast north of Cape Cod, where it is more abundant and where the quahog or hard-shelled clam does not live in any significant quantity. South of

TABLE 1.—MARINE ORGANISMS UTILIZED BY THE WAMPANOAG INDIANS

[All invertebrates are listed by Sumner, Osburn, and Cole (1913) and fishes by Bigelow and Welch (1925) for the region. 1, Collected from Menemsha Bight by Lee (1944). 2, Collected from Menemsha Pond by Dexter and Jeffers. 3, Found in Marthas Vineyard shell-heaps by Byers and Johnson. 4, Found in Nantucket shellheaps by Bullen and Brooks. 5, Reported by Wampanoag informants from Mashpee and Gay Head.]

	1	2	3	4	5
ALGAE:					
Fucus vesiculosis, rock seaweed		+			+
Ascophyllum nodosum, rock seaweed		+			+
Chondrus crispus, Irish moss					+
PELECYPODA:					
Argina campechiensis pexata, combed ark			+		
Ostrea virginica, oyster	+		+	+	+
Pecten irradians, bay scallop		+	+	+	+
P. grandis, deep sea scallop					+
Anomia simplex, jingle shell		+			+
Mytilus edulis, blue mussel		+	+		+
Volsella demissa, ribbed mussel					+
Mercenaria mercenaria, quahog		+	+	+	+
Ensis directus, razor clam		+			+
Spisula solidissima, sea clam		+	+		+
Tagelus gibbus			+		
Mya arenaria, soft-shelled clam			+	+	+
GASTROPODA:					
Polinices heros, sand-collar snail		+	+		+
P. duplicata, sand-collar snail		+	+		+
Crepidula fornicata, boatshell	+	+	+	+	+
Littorina littorea, English periwinkle		+			+
Urosalpinx cinereus, oyster drill		+	+		
Nassarius trivittata, sand snail	+	+	+	+	
N. obsoletus, mud snail			+		
Buccinum undatum, English whelk					+
Busycon canaliculatum, pear conch		+	+	+	+
B. carica, pear conch			+		+
CEPHALOPODA:					
Loligo pealii, squid					+
ARACHNOIDEA:					
Limulus polyphemus, horseshoe crab		+			+
CRUSTACEA:					
Balanus balanoides, rock barnacle					+
B. eburneus (?), ivory barnacle			+		
Homarus americanus, lobster					+
Cancer irroratus, rock crab	+	+			+
Callinectes sapidus, blue crab		+			+
Carcinides maenas, green crab		+			+
Uca spp., fiddler crabs					+
PISCES:					
Squalus acanthias, spiny dogfish			+		+
Raja spp., skates					+
Acipenser sp., sturgeon			+		
Anguilla bostoniensis, eel					+
Pomolobus pseudo-harengus, alewife					+
Osmerus mordax, smelt					+
Scomber scombrus, mackerel					+
Pomatomus saltatrix, bluefish					+
Roccus saxatilis, striped bass					+
Morone americana, white perch					+
Centropristes striatus, sea bass					+
Stenotomus chrysops, porgy					+
Tautogolabrus adspersus, cunner					+
Tautoga onitis, tautog			+		+
Opsanus tau, toadfish					+
Merluccius bilinearis, whiting					+
Gadus morhua, cod					+
Pseudopleuronectes americanus, flounder					+
REPTILIA:					
Sea turtles					+
MAMMALIA:					
Physeter catodon, sperm whale			+		
Globicephala ventricosa blackfish			+?	+	+
Porpoise					+
Phoca vitulina, harbor seal			+		
Halichoerus grypus, gray seal			+	+	

Cape Cod the quahog is now the most valuable of the clams. The soft-shelled clam has, however, been used for the same general purpose as the quahog—steaming, frying, chowder, fritters, pie—but in this case the stomach of the soft-shelled clam is usually removed because of its size and soft texture. This species is not stored because of its poor keeping qualities. It has also been used for bait. After the hurricane and tidal wave of 1938, the soft-shelled clams practically disappeared from the shores of Menemsha Pond. It is believed that they were buried and smothered. In any case this recent and sudden disappearance suggests that similar natural phenomena may be the explanation for variations in the composition of shells in the local kitchen middens from one period of accumulation to another. Byers and Johnson (1940) explained in part the variations in the composition of shell heaps studied by them as a function of the ease of obtaining certain species at certain times. Molluscan populations are known to fluctuate in abundance from time to time to a great degree, sometimes in a cyclical pattern. Some observations of this nature have been published by Dexter (1944). Over long periods of time the ecological balance may change drastically. Thus, for example, in 1931–32 the eelgrass completely disappeared from Menemsha Pond as it did in nearly all other localities along the Eastern Seaboard as the result of a wasting disease. There is evidence that eelgrass decline has been periodic. According to Linus Jeffers the eelgrass returned to Menemsha Pond in 1945. A note on the status of eelgrass in this pond in the summer of 1947 and its relation to the mollusks there has been published by Dexter (1947). Such drastic changes in the natural resources and the consequences of an upset ecological balance are bound to be reflected in the economy of a people who depend wholly or largely on local resources such as the Wampanoag did at one time. Periodic failure of marine populations may account for such conditions as reported by Miller (1880) who wrote that "this lack of food at Massasoit's home indicates a precarious state of subsistence with the Indians."

The sea clam or hen clam (*Spisula solidissima*) has been used for chowder and sometimes for clam pie, after being finely chopped up, but for little else because of its tough texture. It has been used extensively, however, for bait, especially for taking codfish. These clams are dug at low water during the perigee tides. The shells were formerly used for hoes and scrapers. Several other species of bivalves have also been used occasionally for food, but primarily for bait. These include the blue mussel (*Mytilus edulis*), the razor clam (*Ensis directus*), and the ribbed mussel (*Volsella demissa*). The intertidal bivalves were dug out of the muds and sands during times of low tide. In places where the sediments were unusually soft, making standing and walking difficult, the Indians sat down and slid over the flats to obtain the shellfish. Oysters, scallops, and quahogs are sometimes eaten raw. Possibly this practice was more common in older times. In the past century shellfish have been prepared by steaming, frying, stewing, and baking. At one time they were fried in skunk, groundhog, and bird grease. In recent times the shells of bivalves have been burned and used for liming the soil.

One bivalve, the common jingle shell (*Anomia simplex*), played a part in local (Gay Head) Wampanoag fables and myths, in which the shells are referred to as "Granny Squanit's toe nails." These were doubtless used as toys for children because of their bright golden and silver colors and the jingle sounds which they make. On the Chesapeake Bay region the modern Indians string them to make necklaces for their costumes.

Two species of bivalves were recovered from the Vineyard Shell Heap by Byers and Johnson (1940) for which no special use is known. They are *Tagelus gibbus* and the combed ark shell, *Argina campechiensis pexata*. Not many have been recovered, and since they are subtidal forms, they may have been acquired only incidentally along with the collection of common food mollusks. One species which has been used only in recent times is the deep-sea scallop (*Pecten grandis*) which the aboriginal inhabitants doubtless had no means of securing.

It is interesting that fresh-water clams, common in Mashpee Pond, and probably in others as well, never seem to have been utilized either in former or in recent times. Many of the present-day Indians believe them to be poisonous, and the easily available and more palatable marine clams left the fresh-water forms without value.

The marine gastropods or snails also played a leading part in the economy of the Wampanoag. The winkles or pear conchs (*Busycon canaliculatum* and *B. carica*) were ground up, made into a paste, and eaten on bread. A hash and a chowder were also prepared by boiling the chopped snails with vegetables. These snails were also used for bait, and the largest of the shells were used for trumpets. White wampum was manufactured from the columella of these shells. The sand collar snails (*Polinices heros* and *P. duplicata*) and, in recent times at least, the whelk (*Buccinum undatum*), were likewise utilized for food and bait. Boatshells (*Crepidula fornicata*) have long been eaten and are commonly called "sweetmeats." Three species of snails, the sand snail (*Nassarius trivittata*), the mud snail (*N. obsoletus*), and the oyster drill (*Urosalpinx cinereus*) have been found in shell heaps, but there is no evidence as to the nature of their use, if any. The last species named probably reached the refuse piles accidentally on the shells of oysters through which it drills to obtain its food. The other two species may also have been collected incidentally when the food mollusks were gathered.

It is not clear as to what species Chase (1885) refers to by the name of "periwinkle" which he found in Wampanoag shell heaps. Besides having found them in shell deposits, some of the shells perforated for stringing, he reported on a skeleton discovered in South Wellfleet with a necklace consisting of "a double row of common periwinkles." Chase (1885), Byers and Johnson (1940), and Bullen and Brooks (1947) all reported finding small clusters of land snails among the marine shells. Some of these land shells may have been eaten by the natives and possibly some may have been strung for ornaments. However, Ingram (1944) has described the underground storage of land snails by shrews, which behavior should not be overlooked as a possible explanation for the occurrence of such shells in kitchen middens. The two species recovered by Byers and Johnson (1940) and Bullen and Brooks (1947) are among those cited by Ingram in his study. Also, the notation by Byers and Johnson (ibid.) that *recent* shells of a third species of a land snail were found in the heaps indicates without question that they were deposited by some subterranean animal, and very possibly by a shrew.

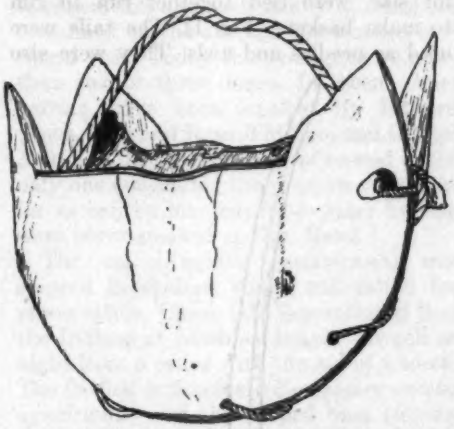

FIG. 1.—Basket made from shells of the horseshoe crab by Grover Ryan of the Gay Head band. Drawing made by Ernest S. Dodge. Specimen in collection of Peabody Museum of Salem.

In recent times a new species has been added to the fauna of the Eastern Seaboard which has been utilized by the modern Wampanoag. The English periwinkle (*Littorina littorea*), which was introduced into North America at the Gulf of St. Lawrence, spread southward very rapidly. According to Morse (1880), this snail was collected at Barnstable on Cape Cod Bay in large quantities in 1875. That year it was rare at Woods Hole on the southern shore of Cape Cod, but by the following year it had become a common species there. These were eaten by the coastal Wampanoag as boiled snails and, after being cooked with vegetables, in the form of hash.

Present-day Indians also eat the common squid (*Loligo pealii*), a cephalopod mollusk. We have no information as to how far back

in time this practice extended. The internal pen or skeleton of this animal would not likely remain preserved in rubbish heaps.

Although the horseshoe crab (*Limulus polyphemus*), one of the most primitive forms of arthropods alive, goes untouched today, it was used extensively in the nineteenth century, if not earlier. First of all it was an item of food. It was boiled and the eggs or roe were eaten much as lobster eggs were eaten at one time. Some also ate the meat from the legs. Then too the shells were used as boat bailers. Other shells, matched for size, were tied together rim to rim to make baskets (Fig. 1). The tails were used as needles and awls. They were also fastened on sticks and used as improvised spears by hunters wading at low tide in shoal water, for the capture of bottom fishes, especially the flounder (Fig. 2). Finally, the chelicerae of the males were saved, polished with repeated rubbing, and carried as good-luck charms. These were commonly called "lucky bones" (Fig. 3).

FIG. 2.—Spear made from tail of the horseshoe crab by Jerry Diamond of the Gay Head band. Nearly natural size. Drawing made by Ernest S. Dodge. Specimen in collection of Peabody Museum of Salem.

FIG. 3.—"Lucky bones," or chelicerae of the horseshoe crab. Natural size. Drawing made by L. R. Tcherky. Specimens in collection of Peabody Museum of Salem.

One informant (Ambrose Pells) reported that he has eaten rock barnacles (*Balanus balanoides*). It is known that in certain areas where large species of barnacles grow they are used to prepare a stew, especially when they are filled with eggs. Probably barnacles were little used by the Massachusetts Indians, however, except possibly as an emergency food. Byers and Johnson (1940) list what is believed to be the ivory barnacle (*Balanus eburneus*) from a shell heap excavated by them. This is a subtidal species, and without question owes its presence in the shell heap to the fact that it was attached to a mollusk shell and hence was collected only incidentally. Other crustaceans, on the other hand, have been valuable items in the food of the Wampanoag. The lobster (*Homarus americanus*) has long been a choice sea food. It was reported by Mrs. Bessie Sturgis that her husband's grandfather was known to capture lobsters with an iron hook in the 1840's and 1850's. These he placed in a back-basket of woven ash while he continued to fish out more of

them from the sand and among the rocks. Later the Indians adopted the white man's method of using lobster pots. For the latter, skate slash was used as bait, the skates being taken by spearing them from a boat with a single-barbed iron spear. Crabs were also captured for food, usually by spearing. The blue crab (*Callinectes sapidus*) has been the most valuable one, but green crabs (*Carcinides maenas*) and rock crabs (*Cancer irroratus*) have been eaten somewhat as well as being used for bait. The fiddler crabs (*Uca* spp.) have been used for bait only.

In spite of the large number of marine invertebrates that have been utilized in one form or another by the Wampanoag, no indication has ever been made of using the echinoderms, the only major group of marine animals for which no information on utility is available. While the white man who settled and has lived on the coast of North America has likewise neglected possible uses of the echinoderms, Europeans have long relished the food value of the sea-urchins, and the sea-cucumbers are eaten in the Far East.

The marine vertebrates, especially the fishes, have also been a very important group in the economy of the Wampanoag people. The most valuable one was the alewife (*Pomolobus pseudo-harengus*), more commonly called locally the fresh-water herring. This should not be confused with the true herring (*Clupea harengus*). The fresh-water herring is an anadromous fish, penetrating into fresh-water ponds from the sea for spawning. It was at such times of migration that the Indians caught them in great quantities and preserved them for future use. Smoked herring was a stable winter food on Cape Cod for many years. During the "run" of the herring, nets were placed in the streams leading to the breeding ponds. The nets were made of twine with a mesh two fingers in width. Only the fingers were and still are used in measuring the mesh, not a wooden gauge. One type of net was square with the corners and center tied to a pole which served to lift the net from the water. Stone sinkers were attached to submerge the nets. Notched sinkers have been recovered from a number of excavations, and Byers and Johnson (1940) reported that such sinkers are still in use today at Gay Head. The herring were salted on the streambank at the time of collection and placed in barrels for four days. They were then dried for three days, after which they were smoked in a smoke house. The fish were suspended on a stick pushed through the eyes, with a dozen or so spaced on one stick. White oak, sugar maple, and sweet fern were burned to produce the smoke. At one time a thousand barrels were taken each season from the Mashpee River. A generation ago each family at Mashpee consumed on the average 300 smoked herring a year. Today the average is no more than two or three dozen. In recent times herring have been smoked by Edward Amos, Tom and Russell Mingo, and George Avant at Mashpee. The first named is the only one continuing the practice today. As far as can be learned, fresh-water herring were never smoked at Gay Head.

The eel (*Anguilla bostoniensis*) was speared in shallow water and salted for preservation. Chase (1885) mentioned that the Indians at Mashpee sought the eels at night from a canoe with the aid of a torch. The flatfish or flounder (*Pseudopleuronectes americanus*) and the striped bass (*Roccus saxatilis*) were speared with the tail of a horseshoe crab attached to a stick as mentioned earlier, or with a stick having a short, sharp side branch at the bottom which served as a barb. Codfishing has been pursued off No Man's Land for many years and continues to the present time, although to a much less extent in recent years. In addition to the flesh, the liver and the sounds (air sacs) are boiled for food. When fish chowder is made, the sounds are left in the fish. The roe is fried. Lucky bones (probably otoliths) were formerly obtained from the head of the cod and carried as a charm. Mrs. Bessie Sturges of Mashpee recalls her grandfather, George Oakley, carrying two such lucky bones. The liver of the spiny dogfish (*Squalus acanthias*) was collected for extraction of oil for lamps. Fred Gardner claims that toadfish or puffer (*Opsanus tau*) was given to sick people to eat because it was believed to be very easily digested. Other fishes in the diet of the Wampanoag

include the following: Skates (*Raja* spp.); smelt (*Osmerus mordax*); mackerel (*Scomber scombrus*); bluefish (*Pomatomus saltatrix*); white perch (*Morone americana*); sea bass (*Centropristes striatus*); porgy (*Stenatomus chrysops*); cunner, or choksi (*tcâkse*), as it is called by the Wampanoag (*Tautogolabrus adspersus*); tautog (*Tautoga onitis*); and whiting (*Merluccius bilinearis*). Miscellaneous and unidentified fish bones have been found in many of the shell heaps which have been studied. Remains of one fish have been found in these refuse piles which no longer lives in the area—Byers and Johnson (1940) uncovered scales of a sturgeon (*Acipenser* sp.). Fish weirs were built in shallow water with nets having notched stone sinkers tied to them for anchorage. Guernsey (1916) quotes from the Massachusetts Historical Collections which describe another method of capturing fish by the Wampanoag as follows. A passage was opened from the sea to Great Pond (now called Squibnocket Pond). Hurdles were sunk to the bottom of the connecting channel in a horizontal position. After the fish had entered the pond, the hurdles were raised to prevent the escape of the fish, which were then sought by spearing from canoes in the shallow water of the pond.

Rock seaweeds (*Fucus vesiculosis, Ascophyllum nodosum*) have been used for keeping the catch of marine animals cool and moist until they were ready for use. This practice is continued today at Gloucester by the world's largest distributor of lobsters, who ships live lobsters all over North America packed in barrels of rock seaweeds. Also, these algae have long been used as packing materials for the famous New England clam bakes. Guernsey (1916) discovered a bundle of seaweed at the bottom of a pit which he believed may have been used as a mattress. The red alga known as Irish moss (*Chondrus crispus*) was used as a source of gelatin.

While there is no archeological evidence that sea turtles were ever captured, such have been eaten in modern times at least. The tooth of a sperm whale (*Physeter catodon*) found by Byers and Johnson (1940) indicates that stranded whales were utilized by the ancient Wampanoag. Remains of a smaller whale, the blackfish (*Globicephala ventricosa*) have also been recovered from shell heaps, and there are historical records which give further information. Chase (1885) quotes an observation made by an exploring party of Gov. John Carver which discovered Wampanoag cutting up a blackfish on the shore of what is now called Blackfish Bay. Both the flesh and the oil were used. When the whaling industry of Massachusetts developed, Wampanoag from Cape Cod and Marthas Vineyard were among the whaling crews. On their trips, porpoises, among other things, were captured for food. Bones of the harbor seal (*Phoca vitulina*) and the gray seal (*Halichoerus grypus*) have been identified from shell heaps, but these animals have not been used for many years, and the gray seal is no longer found in the region.

An ancient tribal festival of the Indians at Gay Head has persisted to the present day. The annual occasion, once a week-long affair, is now referred to as Cranberry Day. The Indians come to the town cranberry bogs for harvesting the crop at the height of the season and to have a social gathering of the townspeople. The youths entertain themselves with games, sports, and contests, and a feast is prepared with shellfish taken from Menemsha Pond nearby. Quahogs, scallops, and clams have been the main foods for some time, but formerly oysters were gathered as well. Guernsey (1916) found two small shell heaps in the dunes close by the cranberry bogs and believed they contained the refuse from such an occasion. In the old wigwam days the inhabitants assembled after driving to the bogs in ox carts. One of the tribal rites at these affairs has come down to recent times, within the memory of living Indians. At the feast, a child was given a basket of food to carry into the dunes to set down at a lonely spot as a gift to old Granny Squanit, and cautioned to hurry away without ever looking back.

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PHYSICS.—*Transition from international to absolute electrical units as it affects the physical chemist.*[1] GEORGE W. VINAL, National Bureau of Standards.

Revised values of the units of electricity and light, effective January 1, 1948, have been adopted pursuant to decisions of the International Committee on Weights and Measures. The definitions of the new "absolute" units and the methods of fixing their magnitudes are quite different from those formerly employed for the practical system of units in use from 1911 to 1947, but the actual changes in magnitude are small and affect only measurements of high precision.

The object of this paper is to indicate briefly (1) what has been done; (2) why a change was made at that time; (3) how much the units are altered; and (4) how the change does or does not affect calculations of the physical chemist in such matters as electrode potentials, activity coefficients, pH, the calorie, free energy, conductivity, and other items.

The absolute system of electrical units is derived from fundamental mechanical units of length, mass, and time by the use of accepted principles of electromagnetism, with the permeability of space taken as unity in the centimeter-gram-second units or as 10^{-7} in the corresponding meter-kilogram-second units. Electrical measurements are thus made concordant with measurements in other fields of science and engineering. This is a guiding principle which has been recognized as desirable since Weber proposed it in 1851. Theoretically this principle is most important, but practically the difficulties in making precise electrical measurements in terms of mechanical units were very great.

An electrical congress, comprising official delegates (Fig. 1) from various countries, met at the World's Fair in Chicago in 1893 and agreed upon definitions for electrical units, recognizing in principle the absolute system but providing concrete standards to represent them. Public law No. 105, 53d Congress, approved July 12, 1894, embodies the decisions of this international body but contains ambiguities which were not recognized until many years later.

As time went on greater accuracy of the standards was needed, and an International Conference on Electrical Units and Standards, meeting in London in 1908, took definitive action to recognize the absolute system of units, but established for practical purposes a separate and independent system based on concrete standards, the mercury ohm, the silver voltameter, and the standard cell.

The electromotive force of the Weston Normal Cell was determined experimentally by a committee, including representatives from four countries who met at the National

[1] This paper was presented on April 19, 1948, at a symposium on batteries and galvanic cells, American Chemical Society, Chicago, Ill. Received June 10, 1948.

FIG. 1.—Official delegates to the International Electrical Congress held at Chicago, 1893. (Courtesy of "Weston Engineering Notes".)

Bureau of Standards in April 1910 (Fig. 2). The international electrical units, in use from 1911 to 1947, were based on these standards. Subsequent measurements of the ohm and ampere revealed differences between the units as realized from these concrete standards and the absolute units based on length, mass and time. The largest discrepancy was in the ohm, amounting to about 1 part in 2,000. Precise measurements of the present day make it very desirable, therefore, that a readjustment should be made.

This step has not been taken without mature deliberation. The American Institute of Electrical Engineers recommended it 20 years ago. The National Bureau of Standards, charged with maintaining the units in this country, consulted an advisory committee consisting of representatives appointed by leading scientific and engineering bodies. The Eighth General Conference on Weights and Measures (an international body) approved the change, which was set for 1940, but for obvious reasons postponed until the present time.

The relation of the fundamental units to the measurement of power and energy in both the new and former systems of units is shown diagrammatically in Fig. 3. The left half represents functions of the National Bureau of Standards, the right half the units and certified standards as you use them in the laboratory. Details of the steps taken may be found in Circular C459 of the National Bureau of Standards, issued May 15, 1947.

MAGNITUDE OF THE CHANGE

Units of the new system will be maintained, as in the past, by standard resistors and standard cells with reassigned values. The relative magnitudes of the ohms and volts in the two systems as accepted by the International Committee on Weights and Measures in October 1946 are as follows:

1 mean international ohm = 1.00049 absolute ohms
1 mean international volt = 1.00034 absolute volts

These are averages of units maintained in national laboratories of France, Germany, Great Britain, Japan, U.S.S.R., and the United States, which took part in the work before the outbreak of the war.

Specifically, the units maintained in the United States by the National Bureau of Standards have differed from the above averages by a few parts in a million, so that the conversion factors for adjusting the above and other values in this country are as follows:

1 international ohm (US)		=1.000495	absolute	ohms
1	" volt (US)	=1.00033	"	volts
1	" ampere (US)	=0.999835	"	ampere
1	" coulomb (US)	=0.999835	"	coulomb
1	" henry (US)	=1.000495	"	henries
1	" farad (US)	=0.999505	"	farad
1	" watt (US)	=1.000165	"	watts
1	" joule (US)	=1.000165	"	joules

These factors should be used in converting values in certificates of the NBS issued previous to January 1, 1948, to the present absolute units.

EFFECT ON CALCULATIONS OF THE PHYSICAL CHEMIST

The calory and thermodynamic quantities.—At various times, quantities of heat energy have been measured in mechanical units, in electrical units, and in thermal units. Various calories, specifically defined, as units of heat energy and based on the absorption of heat by water were measured thermally until about 1910, when it became more usual to measure them in international joules. Difficulties were encountered in introducing the joule as a substitute for the traditional calory and this led to the adoption of an artificial calory[2] for thermochemical purposes. It was defined without reference to water as—

[2] E. F. MUELLER and F. D. ROSSINI, *The calory and the joule in thermodynamics and thermochemistry.* Amer. Journ. Phys. 12: 1. 1944.

FIG. 2.—Members (*) of the International Technical Committee of 1910 and assistants at the National Bureau of Standards. Left to right. F. Laporte* of France, Sir Frank Smith* of England, Dr. F. A. Wolff*, Dr. W. Jaeger* of Germany, M. P. Shoemaker, Dr. S. W. Stratton*, Director N.B.S., Dr. F. Wenner, Dr. A. S. McDaniel, G. E. Post, Dr. F. W. Grover, Dr. E. B. Rosa*, Dr. G. W. Vinal.

1 calory = 4.1833 international joules (NBS).

With the transition from international to absolute units, the calory remains the same but the above relation becomes

1 calory = 4.1840 absolute joules.

Likewise various thermodynamic quantities such as the increment of internal or intrinsic energy, ΔE; increment of heat energy, ΔH; the product of absolute temperature by the change in entropy, $T\Delta S$; the increase of free energy, ΔF; are unchanging physical quantities expressed numerically as joules per mole. Old values in international joules can be converted to corresponding absolute joules by multiplying by the factor 1.000-165.

Table of corrections.—A considerable number of quantities with which the physical chemist has to deal is listed in Table 1.

TABLE 1.—CORRECTION FACTORS

Quantity	Unit of corresponding dimensions	Correction factor int. to abs. units
Activity coefficient	(dimensionless)	no change
Gas constant R	joule, deg^{-1} $mole^{-1}$	×1.000165
Faraday F	coulomb, $g\text{-}equiv^{-1}$	×0.999835
Factor RT/nF	volt	×1.00033
Stand. elec. pot. E°	volt	×1.00033
Redox potentials	volt	×1.00033
Ionization constant	(dimensionless)	no change
Energy & work	joule	×1.000165
Values of pH	(dimensionless)	no change
Brit. Therm. unit	joule	×1.000165
Resistivity	ohm, cm	×1.000495
Conductivity (elec)	ohm^{-1}, cm^{-1}	+1.000495
Ampere-hour	coulomb	×0.999835
Electric potential	volt	×1.00033
Electric field strength	volt, cm^{-1}	×1.00033
Ionic mobility	$volt^{-1}$, cm^2, sec^{-1}	+1.00033
Free energy change	volt, coulomb	×1.000165
Electron charge (emu)	coulomb	×0.999835
Electron volt (emu)	coulomb, volt	×1.000165

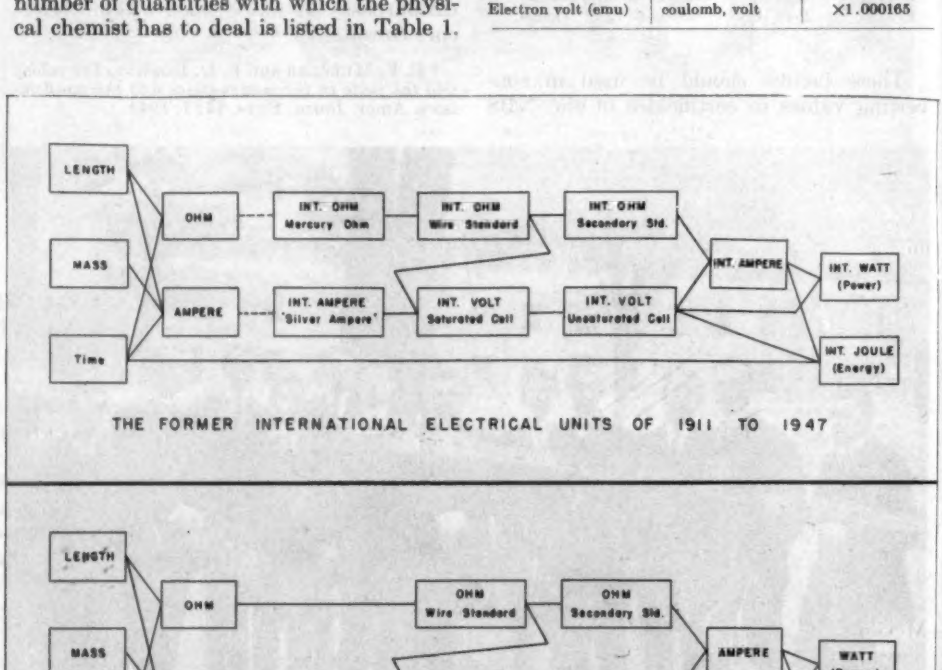

FIG. 3

The corrections given in the last column are factors by which values in international units are to be multiplied (×) or divided (÷) to give the corresponding value in absolute units, provided that electrical measurements are involved. Doubtless the list might be considerably extended but enough are reported to illustrate the principles involved.

The international temperature scale.— Measurements on the international temperature scale by the use of electric thermometers are little, if at all, affected by the change in units. Platinum resistance thermometers involve a ratio of resistances. This is obviously dimensionless and independent of the units. Thermocouple measurements are affected only at high temperatures. At the gold point the correction is 4 microvolts and from this corrections at lower temperatures can be estimated.

BOTANY.—Heliopsis longipes, *a Mexican insecticidal plant species.*[1]

ELBERT L. LITTLE, JR., U. S. Forest Service.

Heliopsis longipes (A. Gray) Blake (family Compositae), common name "chilcuague," is a Mexican herbaceous plant species of possible commercial value as a source of insecticide. In testing various wild plants for new insecticides during the late war, the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, found root extracts from this species to have the same order of paralyzing action and toxicity to house flies as pyrethrins and to be toxic also to other insects.

The dried roots without botanical material for identification had been submitted from a Mexican company under the name *Erigeron affinis* DC. (family Compositae), common names "pelitre del país" and "chilcuán." Acree, Jacobson, and Haller (*1*, *2*, *5*), of the bureau mentioned, isolated from the roots the toxic principle, which they identified as N-isobutyl-2, 6, 8-decatrienoamide and which they named "affinin," from the reported scientific name, Toxicity tests against house flies, mosquitoes, and other insects were made by McGovran and others (*6*), of the same bureau. On the basis of these investigations, R. C. Roark (*11a*), also of this bureau, recently included this species among promising insecticidal plants meriting further research. It seems appropriate, therefore, to report upon the botanical aspects of this insecticide, especially since the scientific name has been confused and not previously known.

The name *Erigeron affinis* for the samples tested apparently was taken from the reference books on Mexican plant names, useful plants, and medicinal plants by Martínez (*7*, *8*, *9*, *10*), who also cited older publications. The early physician Dr. Francisco Hernández (1514–1578), in a work first published in 1615, described a plant, "chilmecatl" or "ychcha," the slender roots of which relieved the toothache and other pains (*4*, pp. 383–384; *15*, p. 121). His description, which Martínez referred to *Erigeron affinis*, is not that of *Heliopsis longipes*.

Erigeron affinis was mentioned in 1902 in Noriega's (*11*, p. 419) Mexican reference on medicinal plants as a substitute for "peritre de Africa," *Anacyclus pyrethrum* DC. and *Anthemis pyrethrum* L., used for rheumatism, neuralgia, toothache, etc., in the following statement (translated from Spanish): "Substituted for it is the root of "chilcuam' or 'peritre del país,' *Erygeron affinis*, which is abundant in the surroundings of Mexico City and is probably the same root abundant in the Sierra de Querétaro, known by the name of 'chilcuán' and *Spilanthes leccabunga* [*beccabunga*] DC., found in Tizapán; their properties appear to be identical."

The following year a chemical analysis of the root of chilcuán (*Erigeron affinis*) by Prof. D. Miguel Cordero (*14*, pp. 237–254) was reported. Escobar (*3*, **1**: 1015, 1194; **3**: 93) in his encyclopedia on agriculture mentioned *Erigeron affinis*, with the com-

[1] This study was made while the author was employed in Mexico in 1945 as production specialist (drugs), by the United States Commercial Company, an agency of the United States Government. Received May 25, 1948.

mon names "chilcuán," "chalchuán," "pelitre," "pelitre del país," and "peritre del país." Santamaría (*12*, 1: 492–493; 2: 450; 3: 450) listed for this species the common names "chalchuán," "chilcagüe," "chilcuague," "chilcuahui," "chilcuán," "pelitre," and "peritre," and associated *Spilanthes beccabunga* with some of these names also.

Martínez' (*7*, pp. 152–155; *9*, pp. 110–112) description of "chilcuán," "chilcuam," or "chilcuague," *Erigeron affinis* DC., as a plant with alternate leaves and white or violet flowers agrees with *Erigeron* and not *Heliopsis longipes*. However, his drawing shows a group of 10 small flower heads on a peduncle, while *Erigeron affinis* has large, solitary, long-peduncled heads. He mentioned various uses for the roots, including stimulation of flow of saliva, relief from toothache, as a dentrifrice, as an insecticide (from the smoke produced by burning), and as a spice substituted for chile in flavoring foods. In San Luis Potosí an alcoholic tincture was applied for pimples, itch, and lice.

Apparently the roots of two or more genera of Compositae with similar properties and similar common names have been confused in the absence of complete botanical specimens. As *Erigeron affinis* was not included in my study, there is no reason to doubt the descriptions of its properties by the authors cited. In May, June, and July, 1945, I made field studies of "chilcuague" in northeastern Guanajuato and collected flowering material, which Dr. S. F. Blake kindly determined as *Heliopsis longipes* (A. Gray) Blake. Earlier references of "chilcuán" from Querétaro, Guanajuato, and San Luis Potosí may apply in part to the same species. A different kind of "pelitre" or "chilcuague," with weaker properties, collected for me by Henry W. Turner at Zamora, Michoacán, was identified by Dr. Blake as *Spilanthes ocymifolia* (Lam.) A. H. Moore. A compound similar to affinin, spilanthol, has been isolated from flower heads of another species of *Spilanthes*.

The discovery of an insecticide in *Heliopsis longipes* is of special interest, as apparently there are no previous reports of insecticidal or medicinal properties in this genus. *Heliopsis* Pers., a genus closely related to *Zinnia* L., consists of about 10 species of American herbs, distributed from Canada and the United States south through Mexico and Central America to Peru. Two of the four species native in the United States, *H. helianthoides* (L.) Sweet and *H. scabra* Dunal, are widely distributed weeds with yellow flower heads resembling sunflowers and have been cultivated as hardy ornamentals. It would be desirable to determine whether other species of this genus have insecticidal properties.

DESCRIPTION OF HELIOPSIS LONGIPES

Heliopsis longipes (A. Gray) Blake, Contr. U. S. Nat. Herb. **22**: 608. 1924.

Philactis longipes A. Gray, Proc. Amer. Acad. Arts and Sci. **15**: 35. 1879.

Common names: "chilcuague," "chilicuague," "pelitre."

Perennial herb or with stems slightly woody and shrubby at base, 2 to 5 dm tall, hirtellous, with one or more stems, spreading and curved to nearly erect, usually unbranched above base, 3 to 7 dm long. Leaves opposite, few, short-petioled, the blades ovate, about 2 to 4 cm long, dentate-serrate. Peduncles 1 to several, terminal, elongate, 10 to 25 cm long, each with a solitary flower head. Involucre of 7 to 9 green ovate or lance-ovate bracts 7 to 10 mm long. Receptable columnar elongated, 10 to 20 mm long. Flowers yellow, rays fertile, about 10, the lamina sessile, about 15 to 18 mm long and 6 mm broad, achenes trigonous—obcompressed, without pappus. Disk flowers fertile, quadrangular and few ribbed, without pappus or with 2 or 4 minute teeth. Bracts of the receptacle 6 to 7 mm long, yellow or orange-tipped, projecting beyond the disk flowers.

This description based upon my additional specimens is modified slightly from that by S. F. Blake (*13*, p. 1527) of the two previous collections, in which the leaves were smaller (to 2.5 cm long) and the rays shorter (about 1 cm long). *Heliopsis longipes* is generally a perennial herb forming new shoots each year from the perennial root system but was properly included by Blake as a "suffrutescent" species in the *Trees and shrubs of Mexico*. Though most stems die back to the ground each autumn, a few of the lowest, purplish internodes, or

sometimes more, may survive the winter and dry spring. Old stems in protected places beneath shrubs may be as long as 6 to 7 dm and only about 1.5 mm in diameter throughout their length. There are also horizontal stems, or rhizomes, near the surface or in leaf litter.

The roots are distinctive, usually fascicled or sometimes single, slightly fleshy, light brown, about 1.5 to 3 dm long and 3 to 4 mm in diameter. These slightly fleshy roots are unbranched, except for a few fibrous lateral roots, and spread out and down at angles in the soil. The leaves are variable, from ovate to oval and from nearly entire to conspicuously toothed. Small, young leaves have relatively denser whitish pubescence. Though usually there are only 1 or 2 flower heads, large plants may have as many as 10 or more flower heads borne on separate elongated peduncles, to which the specific name alludes.

Field recognition of chilcuague in the dormant season is difficult because the plants are low and inconspicuous, with nearly dead stems. However, positive identification can be made by a taste of the roots. In the spring small, immature leaves less than 1 cm long appear on short axillary branches. Growth of stems and leaves is most active in the growing season of summer rains from June to September. Flowers are produced from July to September.

GEOGRAPHIC DISTRIBUTION

Heliopsis longipes is known from southern San Luis Potosí and northeastern Guanajuato and has been reported from northern Querétaro. It is so restricted in geographic distribution and so infrequent that it was known previously to botanists from only two collections in San Luis Potosí, both deposited in the United States National Herbarium. These are the type, collected by C. C. Parry and Edward Palmer (*No. 465*) in 1878 "in valleys along the foothills of the mountains near San Luis Potosí" and the second, by J. G. Schaffner (*No. 763/338*) in 1879. Herb dealers in the city of San Luis Potosí told me in October 1945 that chilcuague grows in the mountainous area south and southeast towards Alvárez. In the State of San Luis Potosí it is restricted apparently to the mountains in the southern part, near the border of Guanajuato, as most of the State is too low in elevation and too arid for it.

In Guanajuato I located *Heliopsis longipes* only in the mountainous area east and north of San Luis de la Paz, about 40 kilometers (25 miles) square. Scattered colonies occur near the highway from San Luis de la Paz east to Xichú. Localities near which this species occurs include: Hacienda de la Mesa, Palmillas, Vergel, Macuala, Ahorcados, La Cueva, Charco Azul, and Santa Catarina. My specimens from several localities have been deposited in the United States National Herbarium and Herbarium of the National Arboretum.

The altitudinal zone of chilcuague in northeastern Guanajuato is from about 1,825 to 2,250 meters (about 6,000 to 7,400 feet). This mountainous area just east of the Continental Divide in the headwaters of the Atlantic drainages is exposed to the easterly winds and receives a higher precipitation than the plateau area around San Luis de la Paz and westward. San Luis de la Paz, elevation 2,020 meters (6,626 feet), is in the semidesert zone and has an annual rainfall of about 370 mm (15 inches). The oak-forest zone, in which chilcuague occurs, extends down the eastern slopes to about 1,825 meters (6,000 feet) near Xichú, elevation 1,400 meters (4,600 feet) and on the western slope near San Luis de la Paz to about 2,125 meters (7,000 feet).

HABITAT

"Chilcuague" (*Heliopsis longipes*) is an undergrowth species of the oak forest, or oak-pine forest, though neither widely distributed nor characteristic. This forest, generally open, is characterized by small oaks ("encinos") 5 to 12 meters or more in height and about 10 to 40 cm. D. B. H., with small to large, thick, evergreen leaves. In some areas the larger trees have been cut for charcoal. The species represented include *Quercus rugulosa* Mart. & Gal., *Q. lanceolata* Humb. & Bonpl., and *Q. macrophylla* Née. Occasionally pines ("pinos"; *Pinus teocote* Schlecht. & Cham.) are associated with the oaks. "Tejocote" (*Crataegus* sp.) is common in places, and

"madroño" (*Arbutus xalapensis* H. B. K.) is relatively sparse. The undergrowth includes scattered herbs and low shrubs, and grasses are characteristic of the open slopes. A few widespread herbaceous species of Compositae resemble chilcuague in having similar yellow flowers and opposite leaves but may be distinguished readily by their smaller, fibrous roots without the peculiar, burning and numbing taste.

Rare and scattered in the oak forests, chilcuague generally is found on the best sites, where the trees are larger and denser, such as gradual to steep, well-drained slopes of mountain sides and canyons. In one area chilcuague plants were observed in open pastures and shrub thickets where the oaks had been cleared. Preliminary observations indicate that plants in partial sunlight grow more rapidly, become larger, flower earlier in the season, and have better-developed root systems than plants in dense shade.

This species has been found only in areas with fertile top soil and adequate soil moisture, usually with a litter of oak leaves, humus, and organic loam soil 10 cm or more in depth. The mineral soil varies from sandy to clay and may be rocky. The entire soil layer on these slopes is only about 30 cm deep, overlying purplish volcanic rock. Chilcuague was not observed on the poorer sites, such as eroded slopes with mineral soil exposed and areas where the undergrowth had been damaged by recent fires.

Soil samples from five localities were analyzed with the Lamotte field tests. The soils were slightly acid, with pH of 6.4 to 6.8. The only serious deficiency was the low nitrogen content of most samples. Phosphorus was average, potassium average to high, sulphates low, and replaceable calcium high.

Small black beetles about 3 mm long and common on the flower heads were determined by H. S. Barber, of the Bureau of Entomology and Plant Quarantine, as *Pristocelis* sp. (family Dasytidae).

ACTIVE PRINCIPLE

When a very small piece (1 or 2 mm long) of fresh or dried chilcuague root is chewed, there is a strong numbing, burning sensation, somewhat anesthetic or paralyzing, in the adjacent parts of the mouth and tongue, lasting for several minutes. Secretion of saliva is stimulated also. In the roots this peculiar, strong taste is nearly all in the outer fleshy part, the pericycle, and very slight in the smaller, fibrous, inner part, mostly xylem. Cut fresh roots have a weak odor similar to the taste. If it is associated with this taste, the active insecticidal principle is almost limited to the underground parts, both the fleshy roots and rhizomes.

Green stems of the current year show a weak but characteristic taste test throughout their length to the flowers. This taste was not detected in old, woody stems of the previous year nor in the leaves. However, the leaves, green stems, and flowers do have a slightly resinous taste common to many composites. The flower heads, including bracts and rays, have a stronger taste than the green stems but weaker than the roots.

It would be desirable to test the flowers to determine whether the active principle is present in significant quantities. It is not known whether the active principle varies significantly in different plants or with age or season.

USES

Use of chilcuague roots is small and mostly restricted to the localities where the species is native. Persons living in the mountains bring in a few bunches to town on the weekly market day. The roots are dug with a pointed steel bar about 0.6 meter long or a similar tool. In being air dried, the roots lose in moisture about two-thirds their weight.

Small bunches of nearly dried, brown roots weighing about 25 bunches to a kilo sold retail at local markets in 1945 for about 20 to 30 centavos (about 5 or 6 cents U. S. currency) a bunch. This retail price was about $6.25 (pesos) a kilo, or 59 cents (U. S. currency) a pound.

The main use is as a sort of spice, because of the property of the root to make the mouth and tongue numb and burn when minute pieces are chewed. The roots are used, like chile, to flavor beans and other foods and to strengthen alcoholic drinks.

It was reported that an extract of the root is used for colds and pneumonia. The root is chewed to relieve toothache. However, there is danger of choking if too much is eaten, and deaths have been reported from this cause.

A small quantity of chilcuague roots is shipped to Mexico City for use in making a local insecticide. The ground root put in a dish of milk has been employed also to kill flies drinking the milk. It is said that larvae of warble flies in the skin of cattle may be killed by putting powdered root in the wound. In the United States use of chilcuague roots in insecticides has been confined to experiments by the Bureau of Entomology and Plant Quarantine.

Possibly medicinal or other uses may be discovered. An alcoholic extract of the root has been tested successfully by dentists as an anesthetic in the extraction of teeth.

PROPAGATION

Preliminary tests of propagating *Heliopsis longipes* were made in Mexico in 1945. If this species should become important commercially, cultivation would be necessary because of the rather limited and poorly accessible supply of the rare wild plants. At four localities with elevations from about 1,800 to 2,400 meters, wild plants were transplanted successfully in rows and beds on a small scale. The plants were dug with picks, most of the tops were cut off, and the roots were trimmed. However, where it was necessary to retain the plants up to a week before transplanting, even though kept moist, survival was low. In spite of the succulent character of the roots, ordinary care must be used in transplanting. When exposed to the air the succulent roots dry out rapidly and shrivel within a week. In tests, cut fleshy roots planted in the ground did not grow, though they remained fleshy as long as a month or more before dying. The marketed dried roots with bases of stems attached will not grow. As the rhizomes sprout readily at the nodes, propagation by rhizome cuttings might be successful. Doubtless chilcuague could be propagated commercially by seeds also, though there was no opportunity to test this method. Roots of suitable size and quantity for harvest should be ready within 2 or 3 years after planting.

Under care, transplants grew better than wild plants. One small plant with a few short stems about 5 cm long in a block of soil 15 cm square and 10 cm thick was transplanted in Mexico City on June 8. It grew rapidly and opened its first flower head on July 21. By July 30, 5 flower heads were open, and by the end of August there were 10 open heads and about 10 more flower buds. More than 40 flower heads had matured by October 5, when 2 flower heads were still open.

SUMMARY

"Chilcuague," a Mexican herbaceous plant species of possible commercial value as a source of insecticide and previously designated as *"Erigeron affinis,"* has been identified as *Heliopsis longipes* (A. Gray) Blake (family Compositae). This species of restricted geographic distribution was known botanically from only two collections in southern San Luis Potosí but now has been found also in northeastern Guanajuato and has been reported from northern Querétaro. In Guanajuato it is rare and scattered in forests of *Quercus* spp. at about 1,825 to 2,250 meters in altitude. The fleshy roots, which produce a strong numbing, burning sensation in the mouth when chewed, are used locally as a spice and are the source of the insecticidal principle. Because of the limited occurrence, cultivation would be necessary to supply commercial quantities of the roots. Wild plants were transplanted successfully on a small scale.

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ENTOMOLOGY.—*New species of* Metachroma *and other chrysomelid beetles from the West Indies.*[1]

DORIS H. BLAKE, Arlington, Va.

This paper contains the description of six new black or dark metallic colored species of *Metachroma* Dejean, a small pale species of *Aphthona* Dejean, and the second species of *Megasus* Jacoby to be described, all of which are from the West Indies.

Megasus semivittatus, n. sp.

Fig. 1

Length 3 mm, faintly shining, pale yellow-brown with a dark median spot extending from occiput down front of head, a dark stripe on each side of prothorax bordering on the explanate margin and a stripe along the sides of the elytra, a short sutural vitta at base and another interrupted one at the middle; also running diagonally across each elytron from apex to humerus a faint orange band. Basal sulcus on prothorax not very distinct and not limited at the ends. Antennae as long as beetle.

Head with interocular space a little more than half its width; occiput smooth, impunctate, a broad median dark stripe extending to above tubercles; tubercles faintly marked, without median groove, bulging slightly over antennal sockets; a fovea on each side near eye. Below antennal sockets on each side a shallow excavation divided in the middle by a narrow, slightly produced carina. Antennae as long as body, joints 2 and 3 short, joints 4–7 long, remainder a little shorter; the basal joints pale, apices of joints 4–11 slightly darker. Prothorax approximately twice as broad as long, with slightly rounded sides, obtuse anteriorly and a sharp tooth at basal angle; a very indistinct and shallow basal groove, not limited at the ends by a longitudinal fovea; surface impunctate, pale, with a dark stripe along the side next to the explanate margin. Elytra a little broader than prothorax and also with a dark stripe along the side extending to the suture at the apex, and at base extending around and down suture but not to the middle, also a short interrupted median stripe at base and middle, and a faint orange diagonal stripe across the elytron; surface impunctate and faintly shining. Body beneath pale, with paler legs. Anterior coxal cavities open, hind femora enlarged, hind tibiae slightly grooved, a short spur at the tip, first tarsal joint long, claws appendiculate. Length 3 mm, width 1.3 mm.

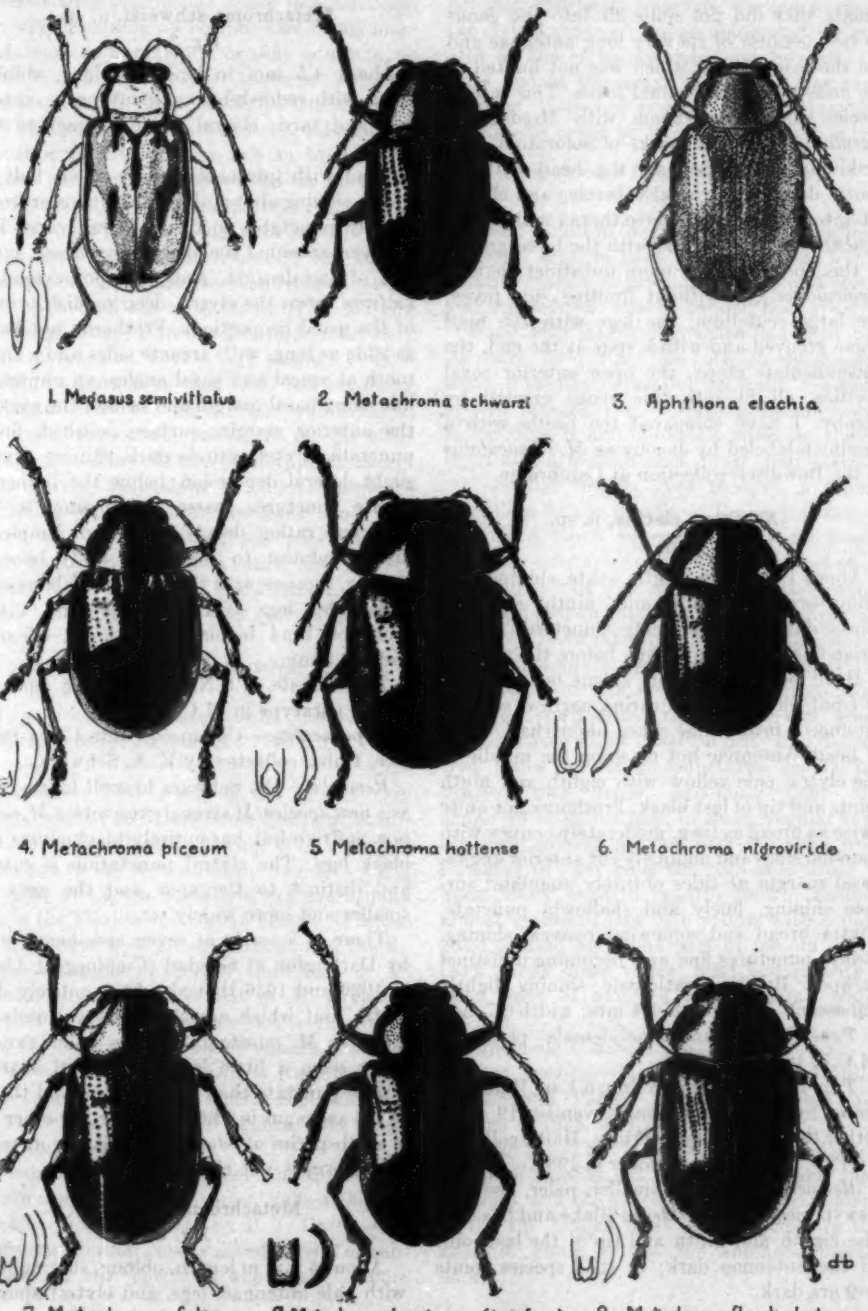
Type male, U.S.N.M. no. 58777,

Type locality.—Mandeville, Jamaica, collected by Van Duzee in April 1906 (from the Wickham collection).

Remarks.—The genus *Megasus* was described by Jacoby[2] to accommodate a beetle from Gua-

[1] Received April 21, 1948.

[2] JACOBY, Biologia Centrali-Americana, Coleoptera, 6(pt. 1): 321. 1884.



FIGS. 1–9.—New West Indian Chrysomelidae.

temala that did not quite fit into the genus *Lactica* because of its very long antennae and the thoracic groove, which was not limited at the ends by a longitudinal fovea. This second species closely corresponds with *Megasus bimaculatus* in all but marks of coloration. The strikingly long antennae, the head with its poorly developed frontal tubercles and closely set antennae, the transverse thorax with its obtuse anterior angles, and with the basal groove in this species rather more indistinct than in *bimaculatus* and without limiting side fovea, the large scutellum, the legs with the hind tibiae grooved and with a spur at the end, the appendiculate claws, the open anterior coxal cavities, all fit into this genus erected by Jacoby. I have compared the beetle with a specimen labeled by Jacoby as *M. bimaculatus* in the Bowditch collection at Cambridge.

Aphthona elachia, n. sp.
Fig. 3

About 1.3 mm. in length, ovate, shining pale yellow-brown, eighth and ninth antennal joints dark; thorax finely punctate, elytral striae fine and disappearing before the apex.

Head polished, a short sulcus on each side of front, interantennal carina narrow, slightly produced, interocular space about half width of head. Antennae not reaching the middle of the elytra, pale yellow with eighth and ninth joints and tip of last black. Prothorax not quite twice as broad as long, moderately convex with rounded sides and obliquely cut anterior angles, basal margin at sides obtusely angulate; surface shining, finely and shallowly punctate. Elytra broad and somewhat convex, shining, striate punctures fine and becoming indistinct at apex. Body beneath pale, shining, lightly pubescent. Length 1.3–1.4 mm; width 0.7 mm.

Type female and one female paratype, M.C.Z. type no. 27828.

Type locality.—Morne Trou d'Eau, Haiti, collected by P. J. Darlington, November 19, 1934. Other locality: Port-au-Prince, Haiti, collected by P. J. Darlington, October 6, 1934.

Remarks.—This is a smaller, paler, less convex species than *A. fraterna* Blake and has only the eighth and ninth and tip of the last joint of the antennae dark; in that species joints 6–9 are dark.

Metachroma schwarzi, n. sp.
Fig. 2

About 4.5 mm in length, oblong, shining black with reddish-brown mouthparts, antennae, and tarsi; elytral striae distinct to the apex.

Head with interocular space about half its width, shining above, alutaceous in lower front, densely punctate, no distinct transverse line between antennal sockets, groove about inner side of eye distinct. Antennae not extending halfway down the elytra, deep reddish brown, of the usual proportions. Prothorax not twice as wide as long, with arcuate sides and a small tooth at apical and basal angles, an impressed line along basal margin and behind the eyes on the anterior margin; surface polished, finely punctate. Elytra entirely dark, shining, a very slight lateral depression below the humerus, striate punctures coarse and distinct to the apex and rather deeply impressed. Epipleura distinct almost to the apex. Body beneath shining, piceous with the tip of the abdomen a little paler, legs dark with pale tarsi, a tiny tooth on hind femora. Length 4.4–4.5 mm; width 2.5 mm.

Type female, U.S.N.M. no. 58778, and one female paratype in M.C.Z.

Type locality.—Cayamas, Santa Clara Province, Cuba, collected by E. A. Schwarz.

Remarks.—Dr. Schwarz himself labeled this as a new species. It strongly resembles *M. adustum* Suffrian but has entirely black elytra and black legs. The elytral punctation is coarser and distinct to the apex and the eyes are smaller and more widely set.

There is a series of seven specimens taken by Darlington at Soledad (Cienfuegos), Cuba, in 1929 and 1936 that also have entirely dark elytra, but which are clearly very closely related to *M. adustum*, if not a color variety. They seem a little less deeply and coarsely striate-punctate than *M. adustum*, and the tip of the aedeagus is a little thinner. Whether this is a subspecies of *adustum* Suffrian or merely a color form is not clear.

Metachroma felis, n. sp.
Fig. 7

About 5 mm in length, oblong, shining black with pale antennae, legs, and elytral apex.

Head with interocular space less than half the width, shining on occiput and front, more alutaceous on lower front, densely punctate, no distinct transverse line between antennal sockets, a slight, short, median vertical groove and the usual groove around eye, labrum and mouthparts reddish or yellowish brown. Antennae pale, extending about to the middle of the elytra, of the usual proportions. Prothorax not twice as wide as long with arcuate sides and a small tooth at each corner, and an impressed line along the sides and basal margin and up behind the eyes on anterior margin; surface polished, with obsolete and moderately dense punctation. Elytra very shining, rows of punctures distinct in basal half but becoming indistinct after the middle and vanishing at the apex, the striate punctures on the sides regular but short. Elytra entirely dark except for a narrow strip along the apex. Epipleura vanishing shortly before the apex. Body beneath deep brown, shining, legs pale with the narrowed apex of femora dark and a dark streak down the tibiae. Hind femora with a small tooth. Length 4.7–5.5 mm; width 2.5–3 mm.

Type male and one female paratype, M.C.Z. type no. 27827.

Type locality.—Arthurstown, Cat Island, Bahamas, collected July 23, 1935, by W. J. Clench.

Remarks.—This is one of the species very closely related to *M. adustum* Suffrian. It differs from the others in having only a narrow pale apex to the elytra and no pale area along the sides or on the humeri, which are usually pale in the Florida and Cuban beetles. It is also slightly larger than either of them, and the tip of the aedeagus is broader than that of *M. adustum* and more like that of *M. terminale* Horn. The elytral striae are not so impressed as in the other closely related species. There is one specimen, a female, in the National Museum collection from Eleuthera, Bahamas, collected in July by H. F. Wickham, that seems to be the same species.

A single specimen, a female, from Constanza, Dominican Republic, elevation 3000–4000 feet, collected in August 1938 by P. J. Darlington, represents another closely allied species or subspecies. In this specimen the head is more polished and finely punctate, the punctures of the elytral striae are not so dense, and the pale area on the elytra extends broadly along the sides and at the apex. This single specimen, however, does not present such distinct differences as occur in *M. schwarzi* and *felis*.

Metachroma flavolimbatum, n. sp.
Fig. 9

About 5 mm in length, oblong, shining piceous with head in part, basal antennal joints, anterior margin of prothorax, margin of elytra and legs reddish, femora banded near apex.

Head with interocular space less than half its width, no distinct line between clypeus and front, a median depression on front, the usual groove around eye; surface alutaceous and rather densely and obsoletely punctate, the occiput and a median area down front piceous, rest reddish brown, jaws piceous. Antennae extending to the middle of the elytra, second and third joints subequal, remainder longer and with only apices pale. Prothorax not twice as broad as long with arcuate sides and a small tooth at basal and anterior angles, an impressed line along basal margin and on sides of anterior margin behind the eyes; surface very finely and obsoletely punctate, mostly shining piceous but reddish brown anteriorly. Elytra with small humeri and a slight basal callosity and depression below it, striate punctures deeply impressed and dense, becoming finer and shallower in apical half, in short, regular rows on sides; shining piceous with the sides from humerus to apex pale, the pale area wider at apex. Body beneath reddish brown, shining, almost glabrous, legs pale yellow with a dark band around narrowed part of femora and a dark streak down tibiae; hind femora with a faint trace of tooth. Length 5 mm.; width 2.8 mm.

Type male U.S.N.M. no. 58779.

Type locality.—Mess Castle near Antully, St. Thomas Parish, Jamaica, collected November 5, 1928, by C. R. Orcutt.

Remarks.—This is another of the *adustum* group of species. It is slightly larger than *adustum*, and the aedeagus has a shorter point to the tip. Unlike most of the species in the *adustum* group it has the antennae mostly dark.

Metachroma piceum, n. sp.
Fig. 4

About 4.5 mm in length, ovate, shining, deep reddish brown to piceous with pale legs, the femora banded at the narrowed apex, tibiae in part darkened, elytra with paler streaks along the basal margin and on humeri and pale along the sides at the apex, base of antennal joints 3–11 dark. All femora mucronate.

Head with interocular space about half its width, rounded over occiput with broad front having a short median depression between the nearly obsolete frontal tubercles; dark piceous with a reddish-brown area on each side of front, lower front and labrum also reddish; surface dull and alutaceous with fine, shallow punctures. Antennae not reaching the middle of the elytra, third joint shorter than fourth, basal joints pale reddish and joints 3–11 darker at the base. Prothorax wider than long with arcuate sides, a small tooth at each corner and an impressed line along basal margin and behind the eyes on anterior margin; surface polished, very minutely punctate; piceous with deep reddish brown streaks along anterior and basal margins, possibly in pale specimens only a piceous transverse band. Elytra striately punctate, the punctures coarsest in transverse depression below basal callosity, becoming fine at apex; shining deep piceous with reddish brown streaks along short raised basal costae and on humeri and a pale margin along the apex, and partly along the sides. Epipleura disappearing before the apex. Body beneath deep reddish brown with tip of abdomen and legs paler, femora near apex banded and tibiae with deeper shading in basal half, all femora with a small tooth, tibiae ridged and emarginate in two hind pairs, claw joint very long. Length 4.4–4.6 mm; width 2.6 mm.

Type male, M.C.Z. type no. 27824; one paratype.

Type locality.—Main Range, Blue Mountains, 5,000–7,388 feet elevation, Jamaica, collected August 17–19, 1934, by P. J. Darlington; paratype collected at Whitfield Hall, Blue Mountains, near 4,500 feet elevation, Jamaica, August 13–20, 1934, by P. J. Darlington.

Remarks.—Although the pale coloration at the apex of the elytra is suggestive of beetles of the *M. adustum* alliance, *M. piceum* does not belong to that group, being more oval and with reddish-brown markings and with more widely set eyes.

Metachroma longitarsum Blake
(dark color form)
Fig. 8

Metachroma longitarsum Blake, Journ. Washington Acad. Sci. **36**: 24. 1946.

A dark color form of this species, represented by three black specimens not associated with the pale reddish-brown spotted female in the original working up of the material, has come to my notice. Except for the dark color these three specimens agree in every way with the pale spotted form, having similar size, shape, and punctation, and furthermore they were collected at the same time and place. They are entirely dark except for the mouthparts, frontal tubercles in part, antennae, and tarsi.

Metachroma nigroviride, n. sp.
Fig. 6

From 4 to 4.5 mm in length, broadly oblong, shining, deep reddish brown to dark metallic green with reddish antennae and legs varying from reddish brown to metallic green, prothorax lightly punctate; elytral striate punctures becoming very fine at apex.

Head with interocular space about half its width, smoothly rounded over occiput and down front, no distinct transverse sulcus between antennal sockets, a faint median vertical line down front in some specimens, the usual groove about inner side of eye; finely and obsoletely punctate, more distinctly in lower front. Antennae reaching about to the middle of the elytra, reddish, the distal joints tending to be darker. Prothorax not quite twice as wide as long, smoothly convex, with arcuate sides and a small tooth at apical and basal angles, surface polished, finely and not densly punctate. Scutellum polished. Elytra with a slight basal callosity, well-marked humeri, and a short intrahumeral depression and slight transverse depression below basal callosity; rows of striate punctures distinct but not very coarse and becoming finer towards apex; epipleura disappearing shortly before apex. Body beneath deep reddish brown to piceous, shining, lightly pubescent, hind femora with a small tooth, tibiae ridged and in middle and posterior pair emarginate near apex. Length 4–4.5 mm; width 2.5–2.6 mm.

Type male, M.C.Z. type no. 27825; 6 paratypes, 1 paratype (no. 58781) in U. S. National Museum.

Type locality.—Puerto Plata, Dominican Republic, collected by Hurst. Other localities: Villa Altagracia, collected in July 1938 by P. J. Darlington; Constanza, elevation 3,000–4,000 feet, collected in August 1938 by P. J. Darlington, both in Dominican Republic.

Remarks.—Three of the eight specimens examined are deep reddish brown without trace of the metallic green of the others. Possibly these are immature specimens.

Metachroma hottense, n. sp.

Fig. 5

About 3 mm in length, broadly oblong, polished dark metallic green with dark brown mouthparts, antennae, legs, and undersurface; head and thorax impunctate, striate punctures on elytra coarsest below basal callosity, on sides and at apex becoming indistinct.

Head with interocular space more than half its width, front broad, flat, impunctate, no transverse groove between antennal sockets; the usual groove running up on inner side of eye. Labrum reddish brown. Antennae scarcely reaching the middle of the elytra, five basal joints reddish, distal joints deep piceous, joints 2–4 subequal and shorter than the remainder. Prothorax not twice as broad as long, moderately convex, with arcuate sides and small tooth at each angle, surface polished, impunctate, basal margin lightly sinuate, an impressed line along it and behind the eyes on anterior margin. Elytra a little broader than prothorax with a short intrahumeral sulcus and a transverse depression below basal callosity, the striate punctures in this coarser than elsewhere, at sides and apex becoming rather indistinct; surface polished. Epipleura disappearing shortly before apex; body beneath dark, shining, lightly pubescent, femora not toothed, tibiae ridged; middle and hind tibiae emarginate near apex. Length 3.2 mm; width 2 mm.

Type male, M.C.Z. type no. 27826.

Type locality.—Desbarriere, Morne La Hotte, Haiti, near 4,000 feet, collected October 12–14, 1934, by P. J. Darlington.

Remarks.—This beetle is considerably smaller than *M. nigroviride* and the thorax differs in not being punctate at all.

ORNITHOLOGY.—*The races of the red-whiskered bulbul*, Pycnonotus jocosus (*Linnaeus*).[1] H. G. DEIGNAN, U. S. National Museum.

The red-whiskered bulbuls may be conveniently divided into two main groups, in one of which adults have the red feathers of the infraocular tuft long and brighter, while in the other they have them short and darker. To the first category belong only *fuscicaudatus*, *abuensis*, *pyrrhotis*, *emeria*, and *peguensis*. A tentative arrangement of the races, with descriptions of two new forms, is offered below.

For the privilege of examining their series of this species, my thanks are hereby tendered to the authorities of the American Museum of Natural History and of the Academy of Natural Sciences of Philadelphia.

1. Pycnonotus jocosus fuscicaudatus (Gould)

Otocompsa fuscicaudata Gould, Proc. Zool. Soc. London, for 1865, pt. 3: 664. March 1866 ("The southern portion of the peninsula of India . . . very common in many parts of the Madras Presidency"; type locality restricted to the Nilgiri Hills, Nilgiri Hills District, Madras Presidency, by Whistler and Kinnear, Journ. Bombay Nat. Hist. Soc. 35: 756. July 15, 1932).

Range.—Western India, from the Tapti River south to Cape Comorin and the Salem District of the Madras Presidency.

2. Pycnonotus jocosus abuensis (Whistler)

Otocompsa jocosa abuensis Whistler, Bull. Brit. Orn. Club 52: 40. Dec. 1, 1931 (Mount Abu, Abu District, Sirohi State, South Rajputana Agency, India).

Range.—Southeastern Rajputana.

Remarks.—This race and the precedent one differ from all others in the absence of conspicuous white tips from the outer tail feathers.

3. Pycnonotus jocosus pyrrhotis (Hodgson)

[Ixos] pyrrhotis Hodgson, *in* J. E. Gray, Zoological Miscellany, No. 3: 84. "June" 1844 (Nepal).

Ixos jocosus v[el]. *pyrrhotis* "Hodgs." J. E. Gray,

[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 16, 1948.

Catalogue of the specimens and drawings of Mammalia and birds of Nepal and Thibet: 89. 1846 (Nepal).

I [xos]. pyrrhotis "Hodgs." Bonaparte, Conspectus generum avium 1: 265, 1850 (India; type locality here corrected to Nepal, *ex* Hodgson).

Otocompsa jocosa provincialis Whistler, Bull. Brit. Orn. Club 52: 40. Dec. 1, 1931 ("Kumaon Bhabar," United Provinces, India).

Range.—The Valley of Nepal, and northern India from the eastern Punjab to Bihar.

Remarks.—Under [*Ixos*] *pyrrhotis* Hodgson, 1844, we find "*I. jocosus*? v[el]. *pyrrhotis*, 209." This seems by the narrowest margin to validate the name from 1844; if, however, the reference is rejected, it seems certain that, by analogy with Opinion 53 of the International Commission on Zoological Nomenclature, the name must be taken from J. E. Gray, 1846. The first proper description attached to *pyrrhotis* was given by Bonaparte in 1850.

4. Pycnonotus jocosus emeria (Linnaeus)

[*Motacilla*] *Emeria* Linnaeus, Systema naturae, ed. 10, 1: 187. 1758 (Bengal).

[*Lanius*] *Emeria* Linnaeus, Systema naturae, ed. 12, 1: 137. 1766 (Bengal).

[*Muscicapa*] *Emeria* Linnaeus, Systema naturae, ed. 12, 1: 326. 1766 (Bengal).

Haematornis erythrotis "Swains." J. E. Gray, Catalogue of the specimens and drawings of Mammalia and birds of Nepal and Thibet: 89. 1846. *Nomen nudum!*

I[xos]. erythrotis "Bp. ex Sw. Mus. Lugd." Bonaparte, Conspectus generum avium 1: 265. 1850 (Java, error; type locality here corrected to Calcutta, Bengal Province, India).

Range.—Lowlands of eastern India from Madras to Calcutta and possibly farther.

Remarks.—The name *erythrotis* was, at its first appearance, a *nomen nudum*, treated as a synonym of "*jocosus*" of J. E. Gray (not the true *jocosus* of Linnaeus), which equals *pyrrhotis* of Hodgson. Since the specimen upon which Swainson based his MS. name is the same as served for type to Bonaparte and is, according to information courteously furnished me by Dr. G. C. A. Junge, almost certainly an example of *emeria*, I feel justified in sinking the name in synonymy with *emeria* rather than with *pyrrhotis*.

Chasen (Handlist of Malaysian Birds: 204. 1935) altered the type locality of *I[xos]. erythrotis* Bonaparte from Java to Tavoy, Tavoy District, Tenasserim Division, Burma, but Dr. Junge's examination of the type specimen has shown that this "correction" can not stand.

5. Pycnonotus jocosus peguensis (Stuart Baker)

Otocompsa emeria peguensis Stuart Baker, Fauna of British India, Birds, ed. 2, 1: 396. Aug. 16, 1922 (Pegu Division, Burma, by implication, and so stated by Stuart Baker, Fauna of British India, Birds, ed. 2, 7: 81. May 14, 1930; type locality here restricted to Rangoon, Rangoon Town District, Pegu Division, Burma).

Range.—Lower Burma from Arakan (Sandoway District) to Tenasserim (Thaton District).

Remarks.—The range given for this form at the original description was "South Chin Hills and South Kachin Hills to Tenasserim, Arrakan and the whole of the Central Hills of Burma, Siam and Shan States. Andamans and Nicobars." My material indicates that no less than four races divide this territory among themselves, of which one, the bird of Pegu, differs strikingly from the other three on its bright, elongated infraocular tufts.

Although I have accepted *peguensis* as a valid subspecies here, I am not at all convinced that this name should not be synonymized with *emeria*.

6. Pycnonotus jocosus whistleri, n. subsp.

Type.—U. S. N. M. no. 178729, adult male, collected at the Cinque Islands (southeast of Rutland Island), Andaman Islands, Bay of Bengal, on January 18, 1901, by William L. Abbott.

Diagnosis.—Nearest *P. j. peguensis* in the brownish tone of the upperparts, but easily separable from that race by having the feathers of the infraocular tuft distinctly shorter and usually darker, and by having the bill, sex for sex, decidedly longer and more robust.

Range.—Andaman Islands; Nicobar Islands (introduced, *fide* Davison, *in* Hume, Stray Feathers 2: 225. 1874).

Remarks.—Thirteen winter-taken specimens of *P. j. whistleri* have been compared with 5 similar examples of *P. j. peguensis* and 29 of the Malayo-Siamese race. For distinctions between the last-mentioned and *whistleri*, see below.

7. Pycnonotus jocosus pattani, n. subsp.

Type.—U. S. N. M. no. 330406, adult male, collected at Pattani (lat. 6°50′ N., long. 101°-15′ E.), Pattani Province, southernmost Siam, on January 26, 1931, by Hugh M. Smith (original number 4479).

Diagnosis.—Nearest *P. j. fuscicaudatus* in the cold grayish-brown tone of the upperparts, but immediately separable from that race by having the feathers of the infraocular tuft short and dark and the majority of the rectrices conspicuously tipped with white.

From *P. j. whistleri* distinguished by having the brown of the upperparts paler and grayer, and by having the bill, sex for sex, shorter and less robust.

From *P. j. monticola* easily separated by having the brown of the upperparts much paler and grayer.

Range.—Indochine south of central Annam and Haut-Laos, all Siam, and Malaya south to Penang Island and Kelantan State.

Remarks.—I can find no character by which southern birds can be distinguished from more northern ones. Specimens before me from the Malay Peninsula seem to have the broken pectoral band more nearly joined across the breast, but this could easily result from their having the body less tightly stuffed with cotton.

8. **Pycnonotus jocosus monticola** (McClelland)

Ixos monticola McClelland, Proc. Zool. Soc. London, March 1840, pt. 7: 160 ("Kossia mountains," Khasi and Jaintia Hills District, Surma Valley and Hill Division, Assam Province, India).

? *Otocompsa jocosa hainanensis* Hachisuka, Orn. Soc. Japan Suppl. Publ. No. 15: 74. Oct. 30, 1939 (Nauchan, Hainan Island).

Range.—Sikkim; Bhutan; Assam; northern Burma and the Shan States; Yunnan; Indochine north of the range of *P. j. pattani*.

Remarks.—I was at first inclined to place all birds from localities between Sikkim and Hongkong under the name *jocosus*, as has been done by British ornithologists, but three Kwantung specimens have the upperparts so much paler than the rest, that for the present I shall keep them apart. McClelland's name is available for the darker populations, but it must be regretted that his type did not come from northeasternmost Assam, where the saturate coloration of the upperparts reaches its highest development.

It is extremely difficult to believe that the unique specimen of *hainanensis* is anything but an escaped cage bird. Whether Hachisuka's name should be synonymized with *monticola* or with *jocosus* cannot be decided without examination of the type.

9. **Pycnonotus jocosus jocosus** (Linnaeus)

[*Lanius*] *jocosus* Linnaeus, Systema naturae, ed. 10, 1: 95. 1758 (China; type locality here restricted to Canton, Kwangtung Province).

Range.—Hongkong, Kwangtung, and adjacent areas of Kwangsi.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

419th MEETING OF BOARD OF MANAGERS

The 419th meeting of the Board of Managers, held in the Cosmos Club, June 7, 1948, was called to order at 8:05 P.M. by the President, Dr. FREDERICK D. ROSSINI. Others present were H. S. RAPPLEYE, H. A. REHDER, W. L. SCHMITT, W. W. DIEHL, F. M. DEFANDORF, W. N. FENTON, WALTER RAMBERG, C. E. WHITE, W. A. DAYTON, C. A. BETTS, F. B. SILSBEE, M. A. MASON, O. B. FRENCH, C. L. GAZIN, and, by invitation, FRANK THONE.

The Secretary read the following minutes of the Executive Committee:

The Executive Committee met in Dr. Rossini's office at the Bureau of Standards at 8:05 P.M. on May 26, 1948. The President, DR. F. D. ROSSINI, presided. Others present were: WALTER RAMBERG, H. S. RAPPLEYE, W. L. SCHMITT, and C. L. GAZIN.

The meeting was called to consider matters pertaining to the annual meeting, intersociety affairs, the Index to the JOURNAL, and the "Red Book."

The subject of the annual meeting in January was discussed, and it was decided to recommend to the Board of Managers that instead of the customary lecture an Academy dinner be held in conjunction with the regular business of the annual meeting.

Dr. Schmitt exhibited a page proof of the "Red Book" and announced that the cost of publication had been determined as follows: Cost of printing, slightly less than $2,000; incidental bills including typing, approximately $500; cost of cuts, a little over $900; totaling approximately $3,400. Discussion then arose as to the adequacy of 1,000 copies and it was suggested that the approximately $200 difference from the maximum of $3,600 allowed for the publication of the "Red Book" be used to print extra copies and absorb the cost of distribution. The cost of additional copies was quoted as $584 per 1,000 and about 60 cents per copy for a smaller number. Upon further discussion it was proposed that a price of $1 be charged for outside purchases but that a prepublication

price of 75 cents per copy be offered to the Affiliated Societies prior to a fixed date, up to which the printer will agree to keep the type set up. The motion was then approved that the Committee recommend to the Board of Managers that the number of copies above 1,000 to be printed be determined by the balance remaining from the original $3,600 as stated above, allowing approximately $75 for distribution costs, and increasing the number still further by whatever quantity is ordered by the Affiliated Societies during the prepublication period.

The matter of an index to the first 40 volumes of the JOURNAL, referred to the Executive Committee by the Board at its 418th meeting, was introduced. After considerable discussion, the Executive Committee voted to recommend to the Board that it authorize, for the necessary expenses of preparing the manuscript, including the materials, a sum not to exceed $2,000, dispersable as required during the period 1949 to 1951, inclusive. It was the feeling of the Committee that outside funds might be secured for the cost of publication.

The matter of the request on the part of the Joint Committee on Press Relations that the Academy pay half of its operating expenses, referred to the Executive Committee by the Board of Managers at its 418th meeting, was introduced. The Committee decided to recommend to the Board that the Academy appropriate to Dr. Frank Thone for discharge of the Academy obligation $62.10 covering the last part of 1947 and all of 1948. The Committee then recommended that the Affiliated Societies be approached concerning the future of the Science Calendar, and if the response accounts for at least 70 percent of the annual cost, that the Academy proceed to act as a collection agency for these contributions from the Affiliated Societies, add the necessary amount from its own funds, and continue to support its share of the project.

The subject of the Science Fair for the secondary-school children was introduced and after some discussion of past arrangements and the manner of its operation in certain other cities, the Executive Committee approved the motion that a recommendation be made to the Board that the Academy appropriate $100 to forward the Science Fair in Washington for 1949, provided that the Fair is sponsored by Science Service, and provided that the necessary balance is secured from other soures.

In consideration of the matter of the Science Calendar and of the Science Fair, discussion was introduced regarding implementation of intersociety activities, and the means whereby a closer coordination might be secured with the Affiliated Societies in such matters. The Executive Committee then agreed to recommend to the Board that the president be authorized to appoint a committee of vice-presidents to study the question of providing a more effective bond between the Academy and the Affiliated Societies.

The Board of Managers considered separately the various recommendations of the Executive Committee and all were approved by vote of the Board, with the exception that, with regard to the recommendation of an annual dinner, the Board approved, providing the dinner be less than $5 per person and preferably less than $3 per person.

As a result of the discussion which ensued with respect to recommendations regarding the Joint Committee on Press Relations, the Secretary was instructed to write letters of appreciation to Mr. Darnell for his work in getting up the "Science Calendar" and to the three Washington newspapers in which it has appeared for their cooperation in its publication. The Secretary was also instructed to contact the Affiliated Societies in the fall, in an attempt to secure their cooperation in the matter of contributions to operating expenses of the Joint Committee on Press Relations, as outlined in the recommendation of the Executive Committee.

The 27 persons nominated for resident membership in the Academy at the 418th meeting were elected.

Upon recommendation of the Treasurer, HOWARD S. RAPPLEYE, the following resolution was passed.

RESOLVED, that the Washington Academy of Sciences transmit its certificates of stock owned in the Washington Sanitary Improvement Co. to the Washington Loan and Trust Co., Transfer Agent, for reissue on the basis of two shares of new stock for each share of old stock, in accordance with the plan outlined in the letter of the Washington Sanitary Improvement Co. under date of May 27, 1948, and that Howard S. Rappleye, Treasurer, be authorized to prepare the necessary transmittal letter, deliver the certificates, and receive the new certificates when issued.

DR. THONE, representing Science Service, recommended to the Board of Managers that the Academy extend its interests to participation in the annual Science Talent Search for the District of Columbia. Upon discussion, the Board decided that before committing the Academy to this program a committee be appointed by the President to study the general matter of encouragement of Science Talent in the schools of the Washington area, the manner in which the Academy might participate, and make recommendations to the Board.

The meeting was adjourned at 10:20 P.M.

C. LEWIS GAZIN, *Secretary.*

PHILOSOPHICAL SOCIETY

1286th Meeting

The 1286th meeting was held in the auditorium of the Cosmos Club, October 11, 1947, President MOHLER presiding.

Program: E. U. CONDON, National Bureau of Standards: *Nuclear forces.*—There was presented a general review of the present position of our knowledge with regard to the nonelectromagnetic forces of interaction between the fundamental particles of physics, electrons, protons, and neutrons. The different sources of experimental information about strength and range of such forces, such as nuclear mass defects and angular scattering data were correlated. (*Author's abstract.*)

1287th Meeting

The 1287th meeting was held in the auditorium of the Cosmos Club, October 25, 1947, President MOHLER presiding.

Program: ROBLEY C. WILLIAMS, University of Michigan: *Recent developments in electron microscopy.*—Some of the recent developments in electron microscopy during the past three years have been: (1) the successful microtomy of sections thin enough to allow 60 kv electrons to penetrate them, (2) the tissue culture of cells of sufficient thinness to allow the nucleus to be observed, (3) the "shadow-casting" of minute particulate specimens to improve the contrast between them and their substrate background, (4) the microincineration of biological specimens to afford an estimate of their ash content, (5) the improvement in substrate smoothness to allow particles of diameters less than 50A to be photographed, and (6) the beginnings of an electron lens technique to allow radioactive specimens to be photographed by means of their own beta particles.

Development (5) has particularly interested the author and his colleagues. They have found that glass is an almost perfectly smooth substrate, with maximum deviations of less than 10A from perfect smoothness. The technique most adaptable to the photography of extremely small objects appears to be to cause the objects to adhere to a cleaned glass surface, shadow-cast them with uranium sulphide, and then strip the particles and the uranium sulphide film from the glass with a thin film of collodion. (*Author's abstract.*)

1288th Meeting

The 1288th meeting was held in the auditorium of the Cosmos Club, November 8, 1947, President MOHLER presiding.

Program: D. C. GINNINGS, National Bureau of Standards: *The Bunsen ice calorimeter in modern heat measurements.*—There was described an improved form of a Bunsen ice calorimeter constructed for use in connection with measurements of specific heats at high temperatures (up to 1,000°C.). The ice calorimeter was investigated carefully from the standpoint of high reproducibility and high accuracy. The calibration factor of the calorimeter (from a large number of electrical calibration experiments) was established to be 270.37 ±0.06 international joules per gram of mercury. Using this factor, the density of ice at 0°C. and one atmosphere pressure was calculated to be 0.91671 ±0.00005 g/ml.

The ice calorimeter was used to measure specific heats at high temperatures by the "drop" method, that is, heating the sample in a furnace to a known temperature, dropping the sample into the calorimeter, and measuring the heat given up by the sample to the calorimeter. Measurements were made in this manner on uranium, uranium trichloride, uranium tetrachloride, aluminum oxide, p-xylene, and isopropyl alcohol. Although the resulting values of enthalpy were reproducible to about 0.02 percent, an over-all accuracy of about 0.2 percent was estimated from consideration of systematic errors such as temperature measurement, etc. (*Author's abstract.*)

A. I. DAHL, National Bureau of Standards: *Temperature measurements in gas streams.*—The temperature indicated by a thermocouple junction immersed in a stream of hot gas will not, in general, be that of the gas but will be an equilibrium temperature representing the state at which the heat transferred from the gas to the junction by convection and impact is balanced by the heat transferred from the junction to the surroundings by radiation and conduction. In applications involving temperatures above 1,000°F. and velocities up to 200–300 ft/sec, the radiation effect is generally the chief source of error.

The effect of gas velocity on temperature measurements becomes appreciable at velocities in excess of 300 ft/sec, and increases as the square of the velocity. At a gas velocity of

1,000 ft/sec, the difference between the total and the static temperature of an air stream is about 80°F. A thermocouple immersed in the stream will attain a temperature somewhere intermediate between the total and static temperatures—assuming no radiation or conduction losses.

The National Bureau of Standards is conducting a research project for the development of means of reducing and determining accurately the effects of radiation, conduction, and gas velocity on temperature measurements in large-velocity, high-temperature gas streams. (*Author's abstract.*)

1289th Meeting

The 1289th meeting was held jointly with the Washington Academy of Sciences in the auditorium of the Cosmos Club, November 20, 1947, President SCHMITT of the Academy presiding.

Program: I. I. RABI, Columbia University: *The hyperfine structure of the hydrogens and other atoms.*

1290th Meeting

The 1290th meeting was held in the auditorium of the Cosmos Club, November 22, 1947, President MOHLER presiding.

Program: J. HOWARD MCMILLAN, Naval Ordnance Laboratory: *Spark shadowgraphy in hydrodynamics.*—The impact of an object on a water surface compresses the water and generates a compression wave which spreads out from the point of impact with the velocity of sound. If the wave is formed by a fast-moving sphere, the wave travels as a shock wave and has a velocity greater than the acoustic velocity. These shock waves were investigated by obtaining their spark shadowgrams. Spheres were shot vertically downward from a rifle into a tank of water 12×6×12 inches with plexiglass sides. The spark was an electronically operated noninductive discharge from a condenser.

The shadowgrams have shown that when steel spheres with a velocity of 1,000 to 3,000 ft/sec strike the water a compression wave with a peak of several hundred atmospheres is generated. The distribution of pressure along the wave front can be inferred from the shadowgram. These impact waves are very strong near the center of the wave and become quite weak (acoustic) near the water surface.

A steel sphere is also set into vibration when it strikes the water. These vibrations have a frequency of nearly a megacycle per second, and a pattern of secondary shock waves appears on the shadowgram. The frequency of the waves depends on the velocity of the elastic wave in the sphere and on the sphere diameter. By shooting two spheres simultaneously, these secondary waves interfere to produce areas of diminished intensity resembling the double-slit optical diffraction pattern.

By permitting the shock waves in water to strike walls having varying acoustic impedances lower than that of water, the waves are observed to reflect with a change in phase. This change in phase also appears at glancing reflection for walls of large acoustic impedance.

If specimens of various elastic media, such as steel and rock, are placed in the water and struck with a missile, dilatation waves and Rayleigh surface waves are produced in the elastic solid. These waves pass into the water and are recorded on the shadowgram. The orientation of the wave in water permits an evaluation of the elastic-wave velocity in the solids.

Spheres shot into water at velocities of 7,000 ft/sec produced shadowgrams of supersonic travel in water, the velocity of sound in water being 5,000 ft/sec. From the refraction of the optical rays the pressure distribution around the missile and shock wave was inferred. It was observed that the pressure did not fall off monotonically in front of the sphere but showed evidence of small ripples in the pressure distribution. (*Author's abstract.*)

A. G. MCNISH, National Bureau of Standards, presented an informal communication on a new theory of the origin of cosmic radiation recently proposed by Menzel and Salisbury. He pointed out that the low frequency electromagnetic radiation from the sun, hypothesized for the theory, could not produce particles of cosmic-ray energies. Particles would have limiting velocities equal to that of light and could not fall far enough in the electric field of the radiation to acquire the necessary energies. Charged particles, however, injected into an electromagnetic wave at suitable velocities would travel with the wave in accordance with the laws of motion of a charge of particle in crossed electric and magnetic fields. Such particles might acquire cosmic-ray energies, but the process could occur only in interstellar

space, not within the confines of the solar system.

1291st Meeting

The 1291st meeting, the 77th annual meeting, was held in the auditorium of the Cosmos Club, December 6, 1947, President MOHLER presiding.

The report of the Treasurer, confirmed by the report of the auditing committed, showed an income from dues and interest on investments of $1,659.41 and expenditures of $1,683.22 leaving a net deficit of $23.81 on ordinary expenses. The ordinary expenses were at the rate of $3.75 per member. The total estimated assets of the Society showed a decrease of $403.01 from $16,377.43 as of December 1, 1946, to $15,974.42 as of December 1, 1947.

The joint report of the Secretaries showed an active membership of 449 as of December 1, 1947, a net gain of 90 active members during the year.

The following persons were elected to membership during the year: P. ABELSON, A. B. ALLEN, R. A. ALPHER, J. ARISTEI, J. M. ASHCROFT, J. V. ATANASOFF, W. H. AVERY, T. F. BALL, L. I. BARBIER, H. C. BEAMAN, W. G. BERL, C. L. M. BLOCHER, F. G. BRAMMER, C. W. BROWN, V. A. BROWN, B. H. BUCKINGHAM, S. A. BUCKINGHAM, D. S. CARDER, A. C. CHARTERS, B. F. CHEYDLEUR, E. U. CONDON, J. H. CURTISS, R. K. DAHLSTROM, S. M. DARR, BESSIE B. DAY, J. DE LAUNAY, M. F. DISTAD, R. L. Dolecek, R. B. DOW, W. H. DUERIG, W. R. DURYEE, G. E. FALK, S. N. FONER, L. W. FRASER, R. C. GIBBS, S. GITHENS, M. P. GIVENS, J. W. GRAHAM, D. E. GRAY, J. B. GREEN, S. HARRIS, G. K. HARTMAN, H. M. HAYLOR, F. B. HAYNES, R. C. HERMAN, H. G. HERTZ, F. K. HILL, W. B. HOLTON, J. J. HOPKINS, G. A. Hornbeck, C. R. HORNER, B. M. HORTON, J. J. JENSEN, MYRTLE R. KELLINGTON, EVELYN M. KENNEDY, R. B. KERSHNER, J. W. KITCHENS, J. H. KUCK, C. J. LAPP, P. J. LARSEN, D. P. LE GALLEY, A. LEVINE, E. S. MANSON, W. H. MARSHALL, L. L. MARTON, H. MASON, F. T. MCCLURE, E. E. MERKEL, S. J. METZLER, C. F. MEYER, H. R. MITCHELL, T. F. C. MUCHMORE, G. C. MUNRO, D. NELSON, P. G. NUTTING, JR., R. M. PARKE, W. PERINE, B. PERKINS, JR., R. B. PETERSEN, H. H. PORTER, J. W. Ray, MINA REES, O. F. RITZMAN, A. L. ROBERTSON, H. M. RYDER, S. N. SAMBUROFF, T. W. SHEPPARD, S. SILVERMAN, E. F. SMELLIE, E. H. SMITH, S. W. SMITH, J. H. SREB, C. E. SWARTZ, H. TATEL, G. R. TATUM, H. A. TELLMAN, H. A. TEMPLIN, A. L. THOMAS, C. A. TRUESDELL, E. A. TURNER, JR., A. J. WADMAN, G. V. WALDO, C. N. WARFIELD, F. D. WERNER, R. E. WILSON, A. W. WUNDHEILER, C. F. Yost.

The Secretaries reported the deaths of H. G. AVERS, C. A. BRIGGS, H. S. ROBERTS, GEORGE SINGER, D. F. WINDENBURG.

Following the reports of the Committee on Elections, the following officers were declared elected for the year 1948: *President*, WALTER RAMBERG; *Vice Presidents*, FRANCIS E. JOHNSTON and FRANK C. KRACEK; *Corresponding Secretary*, ALVIN G. MCNISH; *Treasurer*, ARCHIE I. MAHAN; *Members-at-large of the General Committee*, A. E. RUARK and W. J. ROONEY.

Program: SHIRLEIGH SILVERMAN, Johns Hopkins University Applied Physics Laboratory: *A cinema-spectrograph for photographing rapid spectral sequences.*—A simple spectrograph designed around a 16-mm camera was described. This spectrograph was built for the purpose of obtaining spectrograms from light sources showing transient phenomena, in particular such light sources as the new types of rocket and jet combustion engines. The study of the light emitted from an acetylene-oxygen flame as a function of time illustrated its usefulness. (*Author's abstract.*)

1292d Meeting

The 1292d meeting was held in the auditorium of the Cosmos Club, December 20, 1947, President RAMBERG presiding.

Program: J. B. GREEN, Naval Ordnance Laboratory: *The spectra of atoms.*—During the past 50 years, the spectra of atoms have furnished the most fruitful sources of information regarding the structure of atoms. Even before the isolation of the electron, the discovery of the Zeeman effect and its explanation by Lorentz gave the physicist a measure of the ratio e/m.

The very rapid developments in the theory of atomic spectra, beginning with Bohr's explanation of the spectrum of hydrogen on the basis of the Rutherford atom, and the similarities and dissimilarities of this spectrum with those of other atoms illustrate the correlation of spectra and atomic structure.

The work of Hund on complex spectra showed

how the entire electron configuration was necessary to define the problem. The variations in parameters which determine the coupling coefficients among the electrons can be determined theoretically, and measurements of the Zeeman effect can be used to verify the calculations.

The study of hyperfine structure and its Zeeman effect gave us the first clue that the nucleus of the atom had an intrinsic spin, just as the study of fine structure led to the first evidence of intrinsic spin of the electron.

The ionization potentials of atoms were among the first successes of early theory. It is recommended that the investigation of broad lines excited by atoms in states with sufficient energy to cause auto-ionization be undertaken as a matter of immediate interest in the development of the theory.

During the war great advances in the development of near infrared sensitive materials has given us a powerful tool for the study of atomic spectra in a region which has hitherto been practically unexplored. (*Author's abstract.*)

1293d Meeting

The 1293d meeting was held in the auditorium of the Cosmos Club, January 17, 1948, President RAMBERG presiding.

The retiring president, FRED L. MOHLER, National Bureau of Standards, delivered his presidential address on the subject *Mass spectra of hydrocarbons*. This address was published in this JOURNAL **38**: 193–199. 1948.

1294th Meeting

The 1294th meeting was held in the auditorium of the Cosmos Club, January 31, 1948, Vice President JOHNSTON presiding.

Program: ALVIN G. MCNISH, National Bureau of Standards; *Radio observations of meteor trails.*—Observations of radio echoes from meteor trails by various investigators were summarized. It was then explained how ionization produced by the impact of meteors on the upper atmosphere affords a means for studying processes of recombination, diffusion, and attachment of electrons in the ionosphere. (*Secretary's abstract.*)

1295th Meeting

The 1295th meeting was held in the auditorium of the Cosmos Club, February 14, 1948, President RAMBERG presiding.

Program: FREDERICK SEITZ, Carnegie Institute of Technology: *The theory of plastic flow in solids.*—The high degree of plasticity exhibited by single crystals of metals and close-packed salts presents a fore-front problem of the physics of solids. Elementary reasoning shows that this plasticity must be associated with the presence of lattice imperfections which either exist or can be induced with ease in even the most perfect and pure crystals which are available at the present time. It was suggested by Taylor and Orowan in the last decade that these imperfections are lattice dislocations of the type first introduced by Prandtl to explain internal damping in metals. The theory surrounding dislocations has gradually evolved since it was first proposed, important developments being introduced by Burgers during the early years of the recent war. The relationship between the theory of dislocations and the observed phenomena of plastic flow in single crystals of metals is surveyed in a manner that places particular emphasis upon some of the most recent developments. (*Author's abstract.*)

A. G. MCNISH presented an informal communication describing the peculiar behavior of the F_2-layer in the ionosphere over regions of the earth's magnetic equator.

1296th Meeting

The 1296th meeting was held in the auditorium of the Cosmos Club, February 28, 1948, President RAMBERG presiding.

Program: JOHN STRONG, Johns Hopkins University: *An extension of the application of evaporated films.*—In this illustrated lecture the extension of the applications of aluminizing the astronomical mirrors was traced from its beginnings, when amateur Philip S. Fogg's 6-inch reflector was aluminized in January 1931, to its culmination in the aluminization of the 200-inch Palomar reflector in November 1947. The first metal tank used to coat mirrors to 12-inch diameters was shown by lantern slides. The speaker, together with Dr. Enrique Gaviola, of the Observatory of Córdoba, used this tank to develop methods of parabolizing spheric mirrors, and of correcting the figure of imperfect reflectors, by the deposition of suitably non-uniform aluminum films. The 40-inch aluminizing tank was illustrated in which the mirrors of Dr. Hale's observatory and many mirrors of the Mount Wilson Observatory were coated. The use of this equipment culminated in the

aluminizing of the Crossley reflector of the Lick Observatory in December 1933. The 108-inch aluminising tank used for coating the 60-inch and 100-inch telescope mirrors of Mount Wilson Observatory in February 1935 was illustrated. Finally Mr. Porter's excellent drawings of the new Palomar telescope were projected together with photographs of the aluminized 200-inch mirror. Various details of these large scale operations were discussed. (*Author's abstract.*)

In an informal communication, MICHAEL GOLDBERG, Navy Department, exhibited several models of surfaces resembling ellipsoids of large eccentricities which share with the sphere the property of being rotatable through all possible orientations in space while remaining in contact with the four faces of a regular tetrahedron. The equations of the surfaces and a mathematical demonstration of their unusual property were shown.

A second informal communication was presented by LLOYD JONES, Naval Gun Factory, on the use of certain misleading notations in vector analysis.

1297th Meeting

The 1297th meeting was held in the auditorium of the Cosmos Club, March 13, 1948, President RAMBERG presiding.

Program: JOHN C. HUBBARD,[1] Catholic University of America: *Ultrasonic propagation and its measurement.*—The application of ultrasonics during the late war to testing and location of faults in materials, the finding and continuous recording of depths in the sea, and the measurement of position and velocity of enemy ships, particularly submarines, has raised the subject to a level of popular appreciation and official support little dreamed of at the outbreak of hostilities. The great importance of the subject as compared with audible sound lies in the range of wave lengths which, in general, are small compared even with the dimensions or ordinary tools or apparatus. The recent development at the University of Virginia of electric sparks of extremely short duration has made it possible to photograph progressive ultrasonic waves,[2] showing clearly the effects of diffraction and interference, the spacing of waves in a transparent medium, and the attenuation and change of form of the waves as they progress through the medium. All the experience in this field emphasizes the making of measurements, where accuracy is required, at the lowest possible level of intensity. The application of ultrasonics to the study of elastic and viscous properties of liquids and amorphous and crystalline solids was discussed briefly and the usefulness to the physicist and chemist of ultrasonic data of great precision was shown by means of a number of illustrative examples.

[1] Assisted by the Office of Naval Research.

[2] J. C. HUBBARD, I. F. ZARTMAN, and C. R. LARKIN, *Journ. Opt. Soc. Amer.* **37**: 832–836. 1947.

1298th Meeting

The 1298th meeting was the occasion of the Seventeenth Joseph Henry Lecture and was held in the auditorium of the United States National Museum, March 27, 1948, President RAMBERG presiding.

Program: ROBERT B. BRODE, University of California: *Cosmic-ray mesotrons.* This address will be published in full in this JOURNAL.

1299th Meeting

The 1299th meeting was held in the auditorium of the Cosmos Club, April 10, 1948, President RAMBERG presiding.

Program: F. ZERNICKE, Johns Hopkins University: *Tolerances in lens errors.*

Special Joint Meeting with the Washington Academy of Sciences

This meeting was held in the auditorium of the Cosmos Club, April 15, 1948, President RAMBERG presiding.

Program: PHILIPP FRANK, Harvard University: *Philosophical interpretations of physical theories.*

1300th Meeting

The 1300th meeting was held in the auditorium of the Cosmos Club, April 12, 1948, President RAMBERG presiding.

Program: Col. LESLIE E. SIMON, Aberdeen Proving Ground: *Organization and Administration of German research in World War II.*—The physical conditions for German research in World War II, with emphasis on the most successful kind of research, i.e., for the Air Force, were first discussed. Inasmuch as nearly all research during that time was war research, research agencies sought to identify themselves with the armed services; this, combined with competition between government offices for

research services, caused considerable confusion in the over-all organization for research.

In order to appraise the German effort, the logical flow of contributions to new articles was next discussed. Three defects in the German system appear. First, organizations responsible for development and manufacture did not take research into their confidence. Secondly, research received too little over-all supervision, resulting in unwise duplication. Thirdly, research failed to establish communication with military plans and trends. Therefore, most new articles originated in the design state which was based on past research and were independent of contemporary research. Hence, an enormous amount of research was unremunerative in this respect.

Study of Germany's war research demonstrates that we can not continue to rely on results of past research. It is the duty of industries and government to support currently reasonable amounts of basic research. (*Author's abstract.*)

1301st Meeting

The 1301st meeting was held in the auditorium of the Cosmos Club, May 8, 1948, President RAMBERG presiding.

Program: O. S. DUFFENDACK, Philips Laboratories, Inc.: *Magnetic ferrites.*—Although it was known that certain ferrites have magnetic properties, systematic investigation by Snoek, Verwey, and their co-workers at the Research Laboratories of the Philips Company at Eindhoven, Holland, resulted in the development of magnetic ferrites having desirable characteristics for use as cores of transformers and inductance coils. These ferrites, under the tradename "Ferroxcube," are of different types for different applications, but they are all characterized by high resistivities resulting in low eddy current losses without the necessity of laminating the cores. The hysteresis losses of these materials are low also and special types of "Ferroxcube" have considerable permeability at frequencies in the megacycle range.

Typical characteristics of "Ferroxcube III," which is now in limited production in Eindhoven, are:

Initial permeability u_0 1,000 to 1,500.

Losses, at 60 kc tan δ/u (9.08 to 0.12) $\times 10^{-4}$.

Hysteresis coefficient, at 2 kc (2 to 5) $\times 10^{-6}$. (*Author's abstract.*)

H. M. O'BRYAN, Research and Development Board, presented an informal communication in which he demonstrated a special Perot-Fabry interferometer.

1302d Meeting

The 1302d meeting was held in the auditorium of the Cosmos Club, May 22, 1948, President RAMBERG presiding.

Program: RALPH E. ALPHER, Johns Hopkins University Applied Physics Laboratory: *The origin of chemical elements.*—It is generally accepted that the present relative abundance of elements was established in a prestellar stage of the universe. The direct correlation of relative abundance with nuclear binding energies has suggested to several investigators that the elements were formed in thermodynamic equilibrium at some high temperature and density in this prestellar stage. However, without assumptions difficult to justify physically, it is not possible to explain the abundance of both light and heavy elements as corresponding to equilibrium at a given temperature and density.

Because of the rapid change in physical conditions due to the universal expansion, Gamow suggested several years ago that some non-equilibrium process must have been responsible for the formation of elements. A process of successive neutron captures, with intervening beta-decay to correct the neutron-proton ratio, is indicated by the correlation of nuclei of large abundance with small neutron capture cross sections for these nuclei, and vice versa. Preliminary calculations indicate that a neutron-capture theory leads to the correct relative abundances.

The neutron-capture theory suggests that the cosmological model for the early stages of the universe is one of black body radiation, with a trace of matter present in the form of neutrons, protons, and electrons. Some 300 seconds after expansion began, the temperature had dropped to 10^9°K., below which temperature building up of nuclei by successive neutron captures could go on. At this time the density of matter was of the order 10^{-8} gm/cm^3. The process was terminated in a time of the order of a neutron decay lifetime by neutron decay and by the expansion. (*Author's abstract.*)

WALTER L. CHENEY, *Recording Secretary.*